RESEARCH AND DEVELOPMENT ON POLLUTION FROM TRUCKS AND BUSES

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

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RESEARCH AND DEVELOPMENT ON POLLUTION FROM TRUCKS AND BUSES

WEDNESDAY, JULY 13, 1988

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:18 p.m., in room 2325, Rayburn House Office Building, Hon. Dave McCurdy [chairman of the subcommittee] presiding.

Mr. MCCURDY. The subcommittee will come to order.

This afternoon we are pleased to have a number of witnesses. Mr. Richard Wilson, who is Director of the Office of Mobile Sources, Office of Air and Radiation, Environmental Protection Agency will be our first witness, followed by a distinguished panel.

In the past few weeks people in this city and many other areas across the country have been reminded graphically that the air they breath is often unhealthy. In fact, about one-third of the U.S. population lives in areas which do not meet EPA standards for various pollutants, at least some of the time.

The causes for this are complex. But one well recognized reason, and the one we want to focus on today, is the pollution emitted by diesel-powered buses and heavy-duty trucks.

Add to this, the fact that one of the most objectionable aspects of modern living is being stuck in traffic behind a smoke-belching bus, and you have a subject about which people are genuinely concerned.

Today, the subcommittee will hear testimony on the progress being made to develop heavy duty truck and bus engines that pollute less. There is no question that the witnesses here today will not agree as to how and when truck and bus engines will be able to comply with the tough EPA emissions standards of 1991 and 1994. As the House's technology committee, it is our responsibility to determine whether the research strategy on engines and alternative fuels at the Department of Energy is proper to make a significant contribution to solving this problem. Also, it is appropriate for us to evaluate the acceptance of new engine and fuel technology among the truck and bus companies. For instance, I am particularly concerned that natural gas is not being used to the extent that it could to solve these environmental problems, and am curious to know why the engine companies are depending solely on methanol.

Americans have come to view clean air as almost a God-given right, and I assure you that this subcommittee will expect a lot from the witnesses assembled today in reducing the threats of nitrogen oxides, particulates, and other harmful emissions. I welcome each of you and look forward to a very dynamic discussion. And as I said, we'll start out with Mr. Richard Wilson, if you'll join us at the table, sir.

Donna Fitzpatrick, from the Department of Energy was unable to come today, but submitted a statement for the record, which will be admitted in its entirety in the record at this point.

[The prepared statement of Ms. Fitzpatrick follows:]

STATEMENT OF

DONNA R. FITZPATRICK

ASSISTANT SECRETARY for CONSERVATION

AND RENEWABLE ENERGY

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

U. S. HOUSE OF REPRESENTATIVES

July 13, 1988

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Mr. Chairman and distinguished members of the Committee:

I appreciate your invitation to express the views of the Department of Energy (DOE) on the role of the Department in assisting U.S. industry in the development of truck and bus engines that meet the Environmental Protection Agency (EPA) emissions standards of the 1990s. As you are aware, our primary research role, simply stated, is to develop new sources of energy, to improve the energy yield from available sources, and to find ways to use energy more efficiently. While our primary mission is not to solve industry emissions problems, environmental effects of new energy related technologies are considered in the selection, funding, and implementation of our research programs. My testimony today is structured to provide insight into the nature of the emissions and particulates problem for trucks and buses, the dilemma faced by engine manufacturers, and lastly, the research of the Department relating to this problem.

Nature of the Problem

The Environmental Protection Agency and predecessor Government agencies recognized the potential health hazards associated with diesel exhaust emissions including smoke in the late 1960s. Smoke standards were promulgated starting in 1970 on diesel trucks. Additional emissions control regulations appeared for model year 1974 for carbon monoxide (CO) and combined hydrocarbons (HC) and nitrogen oxides (NOx). The more difficult to control emission (NOx alone) was not controlled until 1984. Diesel particulates

control was initiated in 1988. Further decreases in these two emissions categories have been proposed starting in 1990 and beyond and the problem lies there. The full EPA schedule of diesel emissions regulations appears in Appendix A to my testimony.

Diesel "particulates" have been defined by the EPA to be anything collected on a plastic-coated fiberglass filter at a temperature not to exceed 125^{0}F, excluding condensed water droplets. In practice, diesel particulates consist principally of combustion generated carbonaceous material (soot) on which some organic compounds have been absorbed. The sources of these high molecular weight condensed hydrocarbons are partially burned fuel and lubricating oil. In addition to solid carbon and absorbed organics, there is also a contribution from fuel sulfur. The composition of the particulate matter is dependent on the fuel properties and engine operating conditions, but in general, 50-65 percent of the particulate weight derives from the engine fuel, 20-30 percent is contributed by the lubricating oil, and 10-20 percent is associated with sulfates from fuel sulfur.

Our current understanding of diesel combustion shows particulate and NOx emissions to be closely coupled such that any particulates control strategy appears to have a deleterious effect on NOx control and vice versa. This trade-off is tied fundamentally to the spray combustion process characteristic of all diesels. During spray combustion, soot is formed in large quantities in the fuel rich zone where the injected spray, not yet fully mixed with the surrounding air, is heated by the high temperature flame sheath. Once formed, it is very resistant to destruction via oxidation. Soot oxidation requires

mixing with the surrounding air and then "burning" in the short period of time available before piston expansion causes the in-cylinder gases to cool. The high temperature oxidative environment that is conducive to soot burn-up is, unfortunately, the same environment where NOx is rapidly formed. Thus, engine operational changes that enhance soot oxidation are chemically linked to NOx production.

In addition to the flame-formed soot, the emitted particulates contain sulfates and absorbed organic hydrocarbons. Diesel fuels currently marketed contain 0.3 - 0.35 percent by weight of sulfur. During the combustion process, about 3 percent of the sulfur contained in the fuel is converted to sulfur trioxide that reacts with water vapor to form sulfuric acid (often called "sulfates") that are collected by the filter. Sulfate deposits will also tend to collect an equal weight of water and hold it through weak chemical bonds. Unlike other absorbed water, this "bound" water is not evaporated during the drying process prior to weighing the filter used in the test. In addition, there is a significant fraction of particulate matter evolving from the lubricating oil. Part of the contribution is soluble organics adsorbed on the soot, supplemented by ash, metals and additive residue. In general, both of these emissions appear to be directly proportional to fuel sulfur levels and engine oil consumption.

Industry Reaction

The proposed particulates regulations have received considerable attention by heavy-duty engine manufacturers as a result of the highly competitive international marketplace. U.S. industry is concerned that a technical development by a foreign competitor may force EPA to maintain the current implementation schedule, thus effectively blocking a domestic product from the market. The unattractive alternative, of course, is to pay for the technology developed elsewhere.

The diesel engine manufacturing industry now estimates that they can probably meet the 1991 truck standards by a combination of fuel injection equipment design changes and removal of sulfur from the fuel. However, the more stringent regulations effective in 1994 are uniformly believed to be nearly impossible to meet. These standards are applicable to buses in 1991. Industry is also experimenting with prototype regenerative or catalytic traps to "filter" the exhaust, but this technology has proven unreliable and difficult to engineer for the 200,000 mile useful lifetime of the engine. Thus it appears that the appropriate place to focus is in the cylinder where these particulates are formed in the first place.

Control Approaches

As previously indicated, fuel sulfur makes a significant contribution to the particulates problem. This contribution is augmented by the trends in diesel fuel composition toward fuels characterized by high aromatic content

and high carbon-to-hydrogen ratio. Both characteristics increase the propensity to form particulates. These fuel-related sources of particulates have stimulated considerable debate among fuel producers and engine manufacturers regarding who is responsible for making product modifications to meet the standards. Removing fuel sulfur and improving fuel composition is costly, as a result of increased refining costs, limited sources of low sulfur fuel, and modifications to refinery processing. On the other hand, the engine manufacturing industry asserts that they should not have to bear the total burden. From their perspective, meeting the regulations with engines that use diesel fuel will result in a 5-10 percent reduction in fuel economy, reduced engine life, performance degradation, engine oil contamination, and increased engine complexity and costs.

Limitations of Traditional Control Approaches

In reality, there appears to be inherent limitations to the achievable reductions with the current engine design approach and with the current understanding of the controlling processes. The lubrication oil contribution alone now exceeds the 1994 standards. Creative research and technology development are certainly in order. Revolutionary new approaches to spray combustion and oil control are essential. Mitigating the role of sulfur, or radically reducing its level in fuel, is most important. The use of methanol fuel by the urban bus fleet is now considered by some segments of the diesel manufacturing industry to be the only viable diesel alternative for 1991. While the use of methanol has undergone a low level of fleet demonstration, the performance of the combustion system is far from optimum. Cold start

improvements and light load operation, in addition to engine and injection system durability, are areas that demand further research and development.

The importance of this problem and the inability of current technology to meet the 1994 standards suggest, among other things, that still more knowledge of the combustion process is needed. Developing this understanding is an appropriate Government role and one that is continuing in our combustion research program. Specifically, the focus of the Department's Combustion Technology research program pertaining to diesel engines is on obtaining a fundamental understanding of the in-cylinder particulates formation and destruction processes. This work is managed in our Office of Conservation in the Energy Conversion and Utilization Technologies (ECUT) Program. In addition, the counterpart Alternative Fuels Utilization (AFU) Program of our Office of Transportation Systems supplements this research by generating fundamental design information suitable for industry use.

R&D by the Department Related to the Problem

The three main foci of engine related research and development in DOE have been on: (1) understanding the combustion processes occurring in conventional engines so as to improve their efficiencies while simultaneously reducing the quantities of pollutants in their exhaust; (2) developing new types of engines that offer the potential for higher energy efficiencies with

considerably lower exhaust emissions than conventional internal combustion engines for mobile applications and; (3) conducting research on use of non-petroleum based fuels.

With regard to the first focus of our work, understanding the processes involved, in 1986 DOE strengthened the diesel combustion research of the ECUT Program. Based on responses to a Program Research and Development Announcement (PRDA), five new participants were selected from over 14 proposals submitted to enhance the existing program. The new objective was to develop an improved understanding of critical diesel engine combustion processes to aid in the development of advanced direct-injection engines capable of in-cylinder control of particulate emissions. In this current program, a coordinated experimental and computer modeling actively was initiated. The experimental program involves the application of advanced diagnostics for understanding particulate formation and spray combustion processes in diesel engines. The modeling work builds on the Los Alamos "KIVA" model that has been successfully applied by the U.S. auto industry to the design of advanced homogeneous-charge and direct-injection stratified-charge (DISC) engines. This activity includes four major applied research areas:

(a) Developing more in-depth knowledge of particulate formation mechanisms in diesel sprays and the trade-off between particulates and NOx formation;

(b) Implementing new experimental tools for in-situ measurements of spray properties, particulate concentration, flame structure, temperature, and local fuel-air ratio;

(c) Developing and incorporating new submodels into KIVA to account for soot formation and oxidation, fuel structure effects, and diesel autoignition; and

(d) Exploring the applicability of the RAPRENOx process for NOx removal, and comparing it with other exhaust after treatment technologies. RAPRENOx is a process discovered in our combustion research program to eliminate nearly all the nitrogen oxides from diesel and other exhaust gases. The technology is being developed by private industry for commercial applications.

The ECUT research is coordinated with a cooperative working group organization that has proven to be a model for industry-academia-government interactions. The current corporately funded industry participants in the Diesel Cooperative Working Group include Cummins, Navistar, and Exxon. DOE funded participants include Penn State University, Yale University, PSI Technology, Southwest Research Institute, United Technologies Research Center, Los Alamos National Laboratory, and Sandia National Laboratories. The experiments undertaken by these participants provide a bridge between applied engine development, being undertaken by industry, and basic research on soot formation in flames being sponsored by DOE's Office of Basic Energy Science and by the National Science Foundation.

Industry - National Laboratory Collaborations on the Problem

As part of this DOE program, a strong collaboration has developed between Cummins and Sandia. Cummins has provided Sandia a unique, optically instrumented, diesel engine of production geometry. Cummins has also sent a technical staff member to Sandia for the two year duration of the program. The engine is now installed and initial testing is underway. The approach is to develop and apply a new generation of two-dimensional imaging techniques to measure particulate formation and destruction inside the engine cylinder. Insight developed as a result of these measurements will be used to guide the computer model development being undertaken at Los Alamos.

Also notable is the cost shared collaboration between Los Alamos researchers and Cummins. Cummins, with direct assistance from Los Alamos, is using the KIVA code to examine fuel spray-airflow interactions in their engines. Cummins currently has a technical staff member in residence at Los Alamos where he is learning to use KIVA and optimizing it for Cummins' geometries. In turn, the scientist is providing the Los Alamos staff with insights on current problems facing the diesel engine industry. This is an excellent example of technology exchange.

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DOE Engine Development and Alternative Fuels Research

As noted earlier, there are two other important activities of the Department that relate to the diesel engine. Although the main focus of the research and development activities in our Office of Transportation Systems is on energy conservation, it is a requirement that these research projects have a secondary objective of meeting existing and future environmental regulations. We anticipate that several of the technology developments underway for new engines and fuels will also have positive impacts on regulated emissions, both for light duty applications and heavy duty applications such as trucks and buses.

One engine development activity pertains especially to buses and trucks. The principal goal of our Heavy Duty Transport Program in the Office of Conservation is the development of an industry technology base for the manufacture and commercialization of uncooled (adiabatic) diesel engines with integrated waste heat utilization. Successful implementation of the work in this program could have significant, beneficial effects on exhaust emissions. The greatly increased combustion temperatures should result in a dramatic reduction in particulate formation and also allow for utilization of a wide variety of fuels with improved emission characteristics. The higher temperatures could cause some problems with NOx formation, but the added flexibility for exhaust after-treatment afforded by waste heat utilization systems should offer effective methods to deal with the problem. Because a major source of particulate formation in a diesel is the lubricating oil, the research effort underway for development of an improved high

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temperature liquid lubricant should also help in reducing particulate formation.

Our Automotive Gas Turbine Program has concentrated on light duty transportation applications. However, the technology developed can be applied to heavy duty applications as well. The emissions characteristics and fuel flexibility capabilities of the gas turbine are far superior to the conventional diesel or gasoline engine and should be considered by industry as an additional option for future truck or bus powerplants.

Our AFU Program in the Office of Conservation, conducts research on the use of non-petroleum based fuels in transportation propulsion systems. Although the majority of the work has centered on alternative fuels utilization in spark ignition engines, considerable work has been accomplished (partly in support of the Urban Mass Transportation Administration of the Department of Transportation) with diesel engines operating on alcohols, natural gas and synthetic fuels from oil shale and coal. The research results to date clearly indicate that alternative fuels can play a major role in meeting future emission requirements.

Alcohol fuels and natural gas can contribute in the near term to reduced exhaust emissions and extension of petroleum supplies. Methanol, in particular, offers the prospect for low NOx and essentially no fuel-related particulates.

Research under the AFU Program has shown that test procedures and specifications developed empirically for petroleum products throughout this century do not correlate with synfuels characteristics. These deficiencies also show up in ever increasing instances with petroleum, apparently related to the heavier crude oils that have come into use. Therefore, fundamental research is sponsored by the Office of Conservation to develop a better understanding of all aspects of fuel management in an engine, including fuel chemistry, fuel preparation, fuel injection, ignition, combustion chamber mechanics, and emission formation mechanisms.

DOE Accomplishments Thus Far

What has DOE accomplished so far pertaining to the problem? The following list highlights several selected accomplishments:

- *In response to industry needs, DOE established a program of top industry, university, private R&D and national laboratory researchers focusing on advanced technical approaches including use of methanol and natural gas in production engines, to the diesel NOx/particulate problem.*

- *DOE and its research collaborators developed the capability to model diesel engine air and fuel spray flow dynamics including transient*

spray atomization, evaporation, and mixing. This modeling capability has been transferred to industry, where it is being used to guide injector design.

- *In collaboration with Cummins Engine Company, DOE established a unique capability for in-situ optical observation of particulate formation and destruction in a practical diesel engine.*

- *DOE researchers at Sandia National Laboratories discovered the RAPRENOx process and established data needed to define operational regimes for its application.*

- *DOE-sponsored research provided a rational understanding of the influence of diesel fuel characteristics on ignition performance in engines, including ignition characteristics for alternative fuels, such as alcohols, and ignition improvers under cold start conditions.*

- *DOE has provided industry and academia with the fundamental applications data and state-of-knowledge of alcohol fuels and natural gas/LPG utilization technology for spark-ignition and diesel engines.*

The Department's research and development on energy related phenomena and equipment clearly addresses environmental concerns. We plan to continue our coordinated research agenda. Our fundamental combustion research will be continued to better understand the formation mechanisms of NOx and

particulates in diesel engine cylinders, and our investigations of alternative fuels utilization will provide the required characterization of environmentally acceptable diesel fuel options. These activities, in addition to our efforts to develop new energy efficient and clean propulsion systems, will strengthen the U.S. industry's ability to successfully face the emission control challenges of the 1990s.

This concludes my statement, Mr. Chairman, I thank you for the opportunity to present our views today.

APPENDIX (A)

NEW VEHICLE STANDARDS SUMMARY - DIESEL HEAVY-DUTY ENGINES

The following is a summary of diesel heavy-duty engine standards.[1]

YEAR		HYDRO-CARBONS	CARBON MONOXIDE	OXIDES OF NITROGEN	HYDROCARBONS & OXIDES OF NITROGEN	DIESEL PARTICULATE	SMOKE (opacity)
1970-73		-	-	-	-	-	ACCEL 40% LUG 20%
1974-78		-	40 g/bhp-hr	-	16 g/bhp-hr	-	ACCEL 40% LUG 15% PEAK 50%
1979-83		1.5 g/bhp-hr -	25 g/bhp-hr 25 g/bhp-hr	- -	10 g/bhp-hr 5 g/bhp-hr	- -	ACCEL 20% LUG 15% PEAK 50%
1984[2]	(A)	1.5 g/bhp-hr -	25 g/bhp-hr 25 g/bhp-hr	- -	10 g/bhp-hr 5 g/bhp-hr	- -	ACCEL 20% LUG 15% PEAK 50%
	(B)	1.3 g/bhp-hr 0.5 g/bhp-hr	15.5 g/bhp-hr 15.5 g/bhp-hr	10.7 g/bhp-hr 9.0 g/bhp-hr	- -	- -	ACCEL 20% LUG 15% PEAK 50%
1985-89 later		1.3 g/bhp-hr	15.5 g/bhp-hr	10.7 g/bhp-hr	- -	- -	ACCEL 20% LUG 15% PEAK 50%
1990		1.3 g/bhp-hr	15.5 g/bhp-hr	6.0 g/bhp-hr	- -	0.60 g/bhp-hr -	ACCEL 20% LUG 15% PEAK 50%
1991-93		1.3 g/bhp-hr	15.5 g/bhp-hr	5.0 g/bhp-hr[3]	- -	0.25 g/bhp-hr[3,4] 0.10 g/bhp-hr	ACCEL 20% LUG 15% PEAK 50%
1994 & later		1.3 g/bhp-hr	15.5 g/bhp-hr	5.0 g/bhp-hr[3]	- -	0.10 g/bhp-hr[5] -	ACCEL 20% LUG 15% PEAK 50%

DIESEL HEAVY-DUTY ENGINES

1. Test procedure for 1970-1983 standards is the 13-mode steady-state test procedure. Test procedure for 1984 is either steady-state or the EPA transient test procedure. For 1985 and later, the EPA transient test procedure is used.

2. At the manufacturer's option, either the 1983 standards and test procedures may be used (option A), or standards of 1.3 HC, 15.5 CO, and 10.7 NOx on the transient test procedure (option B). Also, standards of 0.5 HC, 15.5 CO, and 9.0 NOx are optional standards for 1984 diesels tested on the 13-mode test procedure.

3. Emissions averaging may be used to meet this standard, but these emissions may not be averaged with HC gasoline engine emissions. Averaging is restricted to within useful life subclasses (see below). Also, averaging is restricted regionally -- the two regions are California and the other 49 States.

4. For urban bus engines, the standard is 0.10 g/bhp-hr -- particulate averaging is not allowed with this standard, but emissions from these engines may be used in NOx averaging.

5. Emissions averaging may be used to meet this standard. However, averaging is restricted to within useful life subclasses (see below). Also, averaging is restricted regionally -- the two regions are California and the other 49 States. Emissions from engines used in urban buses may not be included in the averaging program.

Additional Requirements

No crankcase emissions are permitted starting in 1984. This does not apply to turbocharged engines or engines whose intake air is inducted solely by pumps, blowers, or superchargers.

Full useful life is established for 1985 and later defined as:

Light heavy-duty (normally under 19,500 lbs GVWR)	--	8 yrs/110,000 miles
Medium heavy-duty (normally 19,500-33,000 lbs GVWR)	--	8 yrs/185,000 miles
Heavy heavy-duty (normally over 33,000 lbs GVWR)	--	8 yrs/290,000 miles

For 1984 (option B only), a number of useful life options are available; for 1984 (option A) and prior years, useful life is 5 years/50,000 miles.

- g/bhp-hr - grams per brake horsepower - hour
- ppm - parts per million
- 13-mode test procedure - diesel engine dynamometer test with 13 steady-state test points
- transient test procedure - engine dynamometer procedure with starts, stops, and speed/load changes

Mr. McCURDY. Mr. Wilson, welcome. We look forward to hearing your testimony. As a runner, I can assure you that the past few days in Washington have not been a pleasant one for either myself or my family. If I don't get to run, then my whole family suffers. And maybe the witnesses that come before us suffer also.

But the air quality has certainly been graphically demonstrated in the past few weeks, and I know the front cover of one of the recent news magazines was on the greenhouse effect, and each of us have vivid memories of being stuck behind a bus or a truck, and I actually owned a diesel car once myself, so it's something that is with us constantly in society.

We appreciate your appearing today, and with that if you have a full statement, it will be admitted into the record in its entirety, and you may summarize, or proceed as you desire.

STATEMENT OF MR. RICHARD D. WILSON, DIRECTOR OF THE OFFICE OF MOBILE SOURCES, OFFICE OF AIR AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY

Mr. WILSON. Thank you very much, Mr. Chairman.

Yes, the air around Washington has looked like Los Angeles. In fact, we've blamed Mr. Boyd, whom you'll hear from later, for thinking that he may have brought some Los Angeles air for us here, to get a real idea what air pollution is like.

EPA, along with the California Air Resources Board have established, I think, the world's most comprehensive motor vehicle emission control program limiting pollution due to passenger cars and light trucks, motorcycles, and heavy-duty engines used in large truck and buses.

The regulations applicable to truck and bus engines control exhaust emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, and particulate matter. In the United States, most cars and light trucks have gasoline engines. Trucks and buses can either have gasoline or diesel engines, but the larger trucks and buses generally are diesel-powered. The contribution of trucks and buses to the total inventory of hydrocarbon and CO emissions due to motor vehicles is relatively small, on the order of 15 percent or less. Automobiles and smaller trucks are the dominant source of these emissions. Trucks and buses constitute a much more significant fraction of emissions of nitrogen oxides, roughly 40 percent, and particulate, roughly 80 percent. Thus EPA's recent attention to heavy-duty engines has centered on the control of these two pollutants. In 1985, EPA established standards for nitrogen oxide and particulate emissions from new heavy-duty diesel truck and bus engines. These standards will significantly and progressively reduce emissions of NO_x in 1990 and 1991, and particulate in 1988, 1991, and 1994. A schedule of these new standards is provided in Table 1, attached to my statement.

In this testimony, I will review EPA's rationale in establishing these standards, the manufacturers' efforts to develop technology in response to them, and EPA's views on the prospect for compliance.

Nitrogen dioxide and particulates are two of six criteria pollutants for which EPA has promulgated National Ambient Air Qual-

ity Standards. These pollutants are considered to cause or contribute to air quality problems which endanger the public health or welfare, and these Ambient Air Quality Standards are limits on ambient concentrations established under the Clean Air Act.

The Ambient Air Quality Standards for nitrogen dioxide protects against respiratory system effects such as altered lung function, respiratory illness, increased susceptibility to infection, and lung tissue damage. NO_2 can also damage vegetation and materials, degrade visibility, and contribute to acid deposition. Only one area, Los Angeles, with a population of 7.5 million, is in non-compliance with the Ambient Air Quality Standard for NO_2.

The Ambient Air Quality Standard for particulate matter is designed to protect sensitive subgroups of the population against such effects as impaired breathing and associated symptoms, aggravation of existing respiratory and cardiovascular disease, and premature mortality. The major welfare effects addressed by the particulate matter standards are soiling and nuisance. In 1987, EPA revised the Air Quality Standard for particulate matter by changing the indicator from one which accounts for total suspended particulates to one which only includes small particles of 10 microns or less. Diesel particulate emissions are all fine particulates, hence under the revised Ambient Air Quality Standard, its contribution to the particulate problem in some non-attainment areas will increase relative to other sources. Further, diesel particulate is emitted at ground level into the breathing zone and is carcinogenic in nature.

Under Section 202(a)(3) of the Clean Air Act we're required to reduce emissions of nitrogen oxides and particulates from heavy-duty truck and bus engines. The Act requires that NO_x emissions from such engines manufactured during and after 1985 be reduced by 75 percent from the baseline, or pre-controlled level. Provision was made to allow EPA to revise the statutorily prescribed standards for any period based on feasibility and cost considerations; however, any relaxed standard must require the maximum degree of control which can be achieved by means expected to be available during the time period in question. Thus, the nitrogen oxide standards are intended to be technology-forcing, requiring the development of pollution control techniques that go beyond present capabilities. The Act presumes that through periodic tightening of the standards, the 75 percent reduction would be achieved unless the agency found that such a reduction was not necessary to protect the public health and welfare.

Section 202(a)(3) also requires that emission regulations for particulate from heavy-duty engines be set to reflect the greatest degree of emission reduction achievable through the application of technology which EPA determines will be available giving appropriate consideration to the cost, noise, energy and safety factors associated with such technology. This language also indicates Congress' desire for EPA to set technology-forcing particulate control standards. Final rules affecting NO_x and particulate emissions for heavy-duty truck engines were promulgated on March 15, 1985.

Since, as noted previously, there is only one area of the country in non-compliance with the nitrogen dioxide standards, the emission standards for NO_x promulgated in 1985 will mainly offset pro-

jected growth in NO_x emissions due to increased economic activity and vehicle miles traveled. The 5.0 grams per brake horsepower-hour standard represents roughly a 26 percent reduction from baseline nitrogen oxide emissions. Since there is a tradeoff between nitrogen oxides and particulate emissions inherent in the diesel combustion process, such that control of one usually results in an increase in the other, EPA's standards favor particulate control. Stringent controls on particulates are more desirable from a health and welfare perspective. The new particulate standards will not only offset growth in emission inventories, but will result in more than a 50 percent net reduction in emissions.

It was thought that compliance with the 1991 and 1994 standards would require development of trap oxidizers, which are essentially filters with the ability to burn off the trapped particulates. In setting the standards, EPA anticipated that 70 percent of the truck engines and 100 percent of the bus engines would require traps to meet the 1991 standards, and 100 percent of the trucks would require them to meet the 1994 standards. Developing this technology by 1991 was seen as an achievable goal, consistent with the technology-forcing mandate of the Clean Air Act.

Since promulgating those standards, EPA has met with all major heavy-duty diesel engine manufacturers that market in the U.S. to review their compliance programs relative to the 1991 and 1994 heavy-duty NO_x and particulate standards. The first review took place in 1986 and the most recent review was completed in May of this year. The objective of this review has been to assess the manufacturers' progress and level of commitment as well as to provide them with EPA's feedback in an effort to improve their compliance programs. Technology development we have observed during this review can be grouped into the areas of engine-out emissions reduction, trap oxidizer development, and oxidation catalyst development.

In the area of engine-out emissions, significant advances have been made. Engine-out emissions are direct emissions from the engine not yet processed by any aftertreatment devise such as a trap oxidizer or catalyst. Today, heavy-duty engines in the field lack aftertreatment devices, thus their engine-out emissions go directly to the atmosphere. EPA and the heavy-duty engine industry previously thought that engine-out emissions of particulate would generally not be able to be reduced below about 0.4 gram per brake horsepower-hour. Thus, as noted previously, we expected that aftertreatment devices such as trap oxidizers would generally be needed to meet the new standards. However, the heavy-duty engine industry has made major engine improvements such that there is a high probability that the 1991 0.25 gram per brake horsepower-hour particulate standard for truck engines will be achievable for almost all engines without aftertreatment.

These engine improvements include fuel injection system optimization, combustion chamber modifications, engine air handling system improvements and reduced oil consumption techniques. Another major change has been the application of electronics to heavy-duty diesel engines, which until now have relied fully on mechanical systems for fuel control. These electronic systems primari-

ly control the fueling event, but can also be used to control air handling and other important engine functions.

Several truck engines have already achieved the level of the 1991 emission standards. Some engine manufacturers have suggested that a reduction in the level of sulfur in diesel fuel is necessary to maximize their chances of compliance with these standards without the use of trap oxidizers.

Current diesel fuel contains about one-third of one percent sulfur, which, when burned, yields sulfur dioxide and a very small quantity of sulfate, which is particulate in nature. Control of fuel sulfur content to very low levels would virtually eliminate the sulfate, reducing total engine-out particulate by approximately 0.05 gram per brake horsepower-hour. Sulfur occurs naturally in crude oil; therefore, its removal would take place during the petroleum refining process.

EPA is performing an extensive study on the matter of diesel sulfur control. Our current plans are to publish the results of this study in the next few months as part of a Notice of Proposed Rulemaking to establish fuel sulfur limits.

EPA is also aware that the diesel engine manufacturers and the petroleum refiners have been attempting over the past several months to develop a joint strategy on the subject of sulfur control in diesel fuel. We have encouraged this effort and are expecting to receive a formal proposal from the two industries very soon.

As I mentioned in my background comments, diesel trap oxidizers were judged in our 1985 rulemaking to be a feasible technology for compliance with the 1991 and 1994 standards. EPA recognized that, whereas the concept was well proven by 1985, a significant level of effort would be required to apply the technology to specific truck and bus applications. In the two years that we have been reviewing the manufacturers' progress on trap development, we have concluded that trap development is still a secondary activity relative to the manufacturers' efforts to reduce engine-out emissions. This is due, in part, to their success in reducing engine-out emissions to a point where traps will not be necessary for 1991 compliance. Many trap oxidizer efforts are focused on high cost, complicated systems.

The last area I'd like to touch on relative to our review of the manufacturers' compliance programs is oxidation catalyst development. An oxidation catalyst for diesel engines is a passive, flow-through after-treatment technology that is similar to an automotive catalytic converter. It is much simpler than a trap oxidizer and should much less costly. We estimate that this technology could significantly reduce particulate levels, depending on the chemical composition of the particulate matter itself. In the past, catalysts have not been considered feasible because of their low efficiency in controlling particulate emissions. However, because the manufacturers have made significant progress in engine-out emissions, the feasibility of oxidation catalysts as a 1994 compliance strategy is being reconsidered. The success of this approach depends in part on fuel sulfur control. Use of catalytic material on a trap oxidizer to enable regeneration of the filters is also an economically desirable option for 1994, and would likewise be dependent on fuel sulfur control.

The last point I'd like to discuss is relative to alternative fuels. Diesel fuel is made up of very complex, heavy hydrocarbon compounds. When this type of fuel is combusted in a diesel engine, a certain amount of particulate will inherently be formed. Some of the much simpler hydrocarbons have great promise as low particulate motor vehicle fuels because they can burn completely and cleanly. Examples of such fuels include methanol, ethanol, compressed natural gas and liquid petroleum gas. Preliminary results indicate substantially reduced emissions of NO_x and particulate when these fuels are used. Thus, we feel that these fuels can help address some of the emissions challenges that face the heavy-duty engine industry. They may be the only technology ready in time for compliance with the 1991 urban bus standards.

Thank you very much, and I'd be pleased to answer any questions.

[The prepared statement of Mr. Wilson follows:]

TESTIMONY OF
RICHARD D. WILSON
DIRECTOR OF THE OFFICE OF MOBILE SOURCES
OFFICE OF AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

JULY 13, 1988

Good afternoon, Mr. Chairman and Members of the Subcommittee. I am Richard D. Wilson, Director of EPA's Office of Mobile Sources and today I would like to speak to you on the subject of EPA's heavy-duty truck and bus engine emission standards. EPA has established a comprehensive motor vehicle emission control program which limits pollution due to passenger cars and light trucks, motorcycles, and heavy-duty engines used in large trucks and buses.

The regulations applicable to truck and bus engines control exhaust emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter. In the United States, most cars and light trucks have gasoline engines. Trucks and buses can have either gasoline or diesel engines, but the larger trucks and buses are generally diesel-powered. The contribution of trucks and buses to the total inventory of HC and CO emissions due to motor vehicles is relatively small, on the order of 15 percent or less. Automobiles and smaller trucks are the dominant source of these emissions. Trucks and buses constitute a much more significant fraction of emissions of NOx (roughly 40 percent) and particulate (roughly 80 percent) because these are the primary pollutants of diesel engines. Thus, EPA's recent attention to heavy-duty engines has centered on the control of these pollutants. In 1985, EPA established standards for NOx and particulate emissions from new heavy-duty diesel truck and bus engines. These standards will significantly and progressively reduce emissions of NOx in 1990 and 1991, and particulate in 1988, 1991 and 1994. A schedule of the new

standards is provided in Table 1. In this testimony, I will review EPA's rationale in establishing these standards, the manufacturers' efforts to develop technology in response to them, and EPA's views on the prospects for compliance. The discussion will include a brief review of the potential for alternative fuels to assist in the compliance effort.

Environmental and Health Impacts of NOx and Particulates

Nitrogen dioxide (NO_2) and particulates are two of six criteria pollutants for which EPA has promulgated National Ambient Air Quality Standards (NAAQS). These pollutants are considered to cause or contribute to air quality problems which endanger the public health or welfare, and the NAAQS are limits on ambient concentrations established under the Clean Air Act. To clarify terms, NOx is a generic term referring to both NO_2 and nitrogen monoxide, NO. Since NO converts to NO_2 in the atmosphere, it is included together with NO_2 in vehicle emission standards that control NOx generally.

The NAAQS for NO_2 protects against respiratory system effects such as altered lung function, respiratory illness, increased susceptibility to infection, and lung tissue damage. NO_2 can also damage vegetation and materials, degrade visibility, and contribute to acid deposition. Today, only one area, Los Angeles, with a population of 7.5 million, is in non-compliance with the NAAQS for NO_2.

The NAAQS for particulate matter is designed to protect sensitive subgroups of the population against such effects as impaired breathing and associated symptoms, aggravation of existing respiratory and cardiovascular disease, and premature mortality. The major welfare effects addressed by the particulate matter NAAQS are soiling and nuisance. In 1987, EPA revised the NAAQS for particulate matter by changing the indicator for particulate matter from one which accounts for

total suspended particles to one that includes only particles with an aerodynamic diameter of 10 microns or less (PM10). Diesel particulate is a fine particulate, hence under the revised NAAQS, its contribution to the particulate problem in some non-attainment areas will increase relative to other sources. Furthermore, it is emitted at ground level into the breathing zone and is carcinogenic in nature.

Responsibility for achieving compliance with the NAAQS is located at both the state and Federal levels. States are responsible for developing plans that demonstrate attainment and maintenance of the NAAQS and for implementing pollution control measures on the local level. EPA is responsible for monitoring states' progress, developing nationwide pollution controls where appropriate, and for implementing specific measures prescribed by Congress. In the case of NOx and particulate emissions from heavy-duty trucks and buses, EPA has set national standards consistent with both the need to achieve compliance with the NAAQS and with specific requirements imposed by Congress.

The 1985 Rulemaking

Section 202(a)(3) of the Clean Air Act (as amended in 1977) includes requirements for reducing emissions of NOx and particulates from heavy-duty truck and bus engines. The Act requires that NOx emissions from such engines manufactured during and after 1985 be reduced by 75 percent from the baseline, or pre-control, emissions of gasoline-fueled heavy-duty engines. Provision was made to allow EPA to revise the statutorily prescribed standards for any period based on feasibility and cost considerations; however, any relaxed standard must require the maximum degree of control which can be achieved by means expected to be available during the time period in question. Thus, the NOx standards are intended to be "technology-forcing," requiring the development of pollution control techniques that go beyond present capabilities. The Act presumes that through periodic

tightening of the standards, the 75 percent reduction would be achieved unless the Agency found that such a reduction was not necessary to protect the public health and welfare.

Section 202(a)(3) also requires that emission regulations for particulates from heavy-duty engines be set to reflect the greatest degree of emission reduction achievable through the application of technology which EPA determines will be available giving appropriate consideration to the cost and to noise, energy, and safety factors associated with such technology. This language also indicates Congress's desire for EPA to set technology-forcing particulate control standards. Final rules affecting NOx and particulate emissions for heavy-duty engines were promulgated on March 15, 1985. Except for a subsequent legal appeal which resulted in delay in the date of applicability of the new NOx standards to 1990 (from 1988), the standards apply as originally promulgated.

Since, as noted previously, there is only one area of the country in non-compliance with the NO_2 NAAQS, the NOx emission standards promulgated in 1985 will mainly offset projected growth in NOx emissions due to increased economic activity and vehicle miles traveled. The 5.0 grams per brake horsepower-hour (g/BHP-hr) standard represents roughly a 26 percent reduction from baseline NOx emissions. Since there is a tradeoff between NOx and particulate emissions inherent in the diesel combustion process, such that control of one usually results in an increase in the other, EPA's standards favor particulate control. Stringent controls on particulates are more desirable from a health and welfare perspective. The new particulate standards will not only offset growth in emissions inventories - particulate emissions from diesel trucks and buses were projected to increase by more than 50% by the year 2000 without controls - but result in more than 50 percent net reduction in emissions.

It was thought that compliance with the 1991 and 1994 standards would require development of trap oxidizers, which are essentially filters with the ability to "burn off" the trapped particulates. In setting the standards, EPA anticipated that 70 percent of truck engines and 100 percent of bus engines would require traps to meet the 1991 standards, and 100 percent of trucks would require them to meet the 1994 standards. Developing this technology by 1991 was seen as an achievable goal, consistent with the "technology-forcing" mandate of the Clean Air Act.

EPA's Review of Compliance Efforts

EPA has met with all major heavy-duty diesel engine manufacturers that market in the U.S. to review their compliance programs relative to the 1991 and 1994 heavy-duty NOx and particulate standards. The first review took place in 1986 and the most recent review was completed in May of this year. The objective of this review has been to assess the manufacturers' progress and level of commitment as well as provide them with EPA's feedback in an effort to improve their compliance programs. Technology developments we have observed during this review can be grouped into the areas of engine-out emissions reductions, trap oxidizer development, and oxidation catalyst development.

In the area of engine-out emissions, significant advances have been made. Engine-out emissions are direct emissions from the engine not yet "processed" by an aftertreatment device such as a trap oxidizer or catalyst. Today, heavy-duty engines in the field lack aftertreatment devices, thus their engine-out emissions go directly to the atmosphere. EPA and the heavy-duty engine industry previously thought that engine-out emissions of particulate (at a 5.0 g/BHP-hr NOx level) would generally not be able to be reduced below about 0.4 g/BHP-hr. Thus, as noted previously, we expected that aftertreatment devices such as trap oxidizers would generally be needed to meet the new standards.

However, the heavy-duty engine industry has made major engine improvements such that there is a high probability that the 1991 0.25 g/BHP-hr particulate standard for truck engines will be achievable for almost all engines without aftertreatment.

These engine improvements include fuel injection system optimization, combustion chamber modifications, engine air handling system improvements and reduced oil consumption techniques. Another major change has been the application of electronics to heavy-duty diesel engines, which until now have relied fully on mechanical systems for fuel control. These electronic systems primarily control the fueling event, but can also be used to control air handling and other important engine functions.

Several truck engines have already achieved the level of the 1991 emission standards. Some engine manufacturers have suggested that a reduction in the level of sulfur in diesel fuel is necessary to maximize their chances of compliance with these standards without the use of trap oxidizers.

Current diesel fuel contains about one third of one percent sulfur, which, when burned, yields sulfur dioxide and a very small quantity of sulfate, which is particulate in nature. Control of fuel sulfur content to very low levels would virtually eliminate the sulfate, reducing total engine-out particulate by approximately 0.05 g/bhp-hr. Sulfur occurs naturally in crude oil; therefore, its removal would take place during the petroleum refining process.

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EPA is also aware that the diesel engine manufacturers and the petroleum refiners have been attempting over the past several

months to develop a joint strategy on the subject of sulfur control in diesel fuel. We have encouraged this effort and are expecting to receive a formal proposal from the two industries very soon.

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The last area that I would like to touch on relative to our review of the manufacturers' compliance programs is oxidation catalyst development. An oxidation catalyst for diesel engines is a passive, flow-through after-treatment technology that is similar to an automotive catalytic converter. It is much simpler than a trap oxidizer and should be much less costly. We estimate that this technology could significantly reduce particulate levels, depending on the chemical composition of the particulate matter itself. In the past, catalysts have not been considered feasible because of their low efficiency in controlling particulate emissions. However, because the manufacturers have made significant progress in engine-out emissions, the feasibility of oxidation catalysts as a 1994 compliance strategy is being reconsidered. The success of this approach depends in part on fuel sulfur control. Use of catalytic material on a trap oxidizer to enable regeneration of the filters is also an

economically desirable option for 1994, and would likewise be dependent on fuel sulfur control.

The last point that I would like to discuss is relative to alternative fuels. Diesel fuel is is made up of very complex, heavy hydrocarbon compounds. When this type of fuel is combusted in a diesel engine, a certain amount of particulate will inherently be formed. Some of the much simpler hydrocarbons have great promise as low particulate motor vehicle fuels because they can burn completely and cleanly. Examples of such fuels include methanol, ethanol, compressed natural gas and liquid petroleum gas (LPG). Preliminary results indicate substantially reduced emissions of NOx and particulate when these fuels are used. Thus, we feel that these fuels can help address some of the emissions challenges that face the heavy-duty engine industry. They may be the only technology ready in time for compliance with the 1991 urban bus standards.

Thank you very much. I would be pleased to try to answer any questions the Subcommittee may have on these issues.

Table 1

PARTICULATE EMISSION STANDARDS FOR HEAVY-DUTY DIESEL ENGINES

Model Year	Particulate (g/BHP-hr)	NOx (g/BHP-hr)	Comments
1988	0.60	10.7	First HDDE particulate standard
1990		6.0	Delayed from 1988 by court order
1991	0.25	5.0	All HDDE's except urban buses; averaging permitted
	0.10	5.0	Urban buses only; no averaging
1994	0.10	5.0	All HDDE's; averaging permitted (buses excluded)

Mr. McCURDY. Thank you, Mr. Wilson.

On your Table 1 attached to your testimony, is the listing of the years and the emissions that are under review, and would you explain that graph a little more, or that table, for the record?

Mr. WILSON. I'd be happy to.

When we were setting the standards in 1985, we had a recommendation from the heavy-duty industry that we not only promulgate a standard for the next point in the future, but lay out what we thought was a series of standards that would force technology and get to the end points that were required, so that everybody knew what the long-term obligations were. We picked up on that and developed a series of standards that apply in 1988, 1991, and 1994, and get progressively more stringent.

As you can see, then, in 1988 the particulate standard became, this year became, 0.6 with a NO_X standard of 10.7. The NO_X standard itself was originally promulgated— 0.6 was originally promulgated for 1988, but a court order required us to delay that until 1990. And then in 1991 for all heavy-duty engines except urban buses, the particulate standard goes to 0.25 and the NO_X standard goes to 5.0. And then for urban buses in 1991, the standards for particulate is 0.1, and for NO_X it's 5.0. In 1994 all heavy-duty engines are required to meet a 0.1 particulate and a 5.0 gram NO_X standard.

Mr. McCURDY. Could you tell us, as to the standard in 1988 on the particulate, did you say that only the Los Angeles metropolitan area is in non-attainment on that?

Mr. WILSON. They're the only area of non-attainment for ambient air quality of nitrogen dioxide.

Mr. McCURDY. Nitrogen dioxide.

Mr. WILSON. Nitrogen oxides have three different roles they play in environmental issues. One of them is they contribute to nitrogen dioxide as measured in cities. Second is they contribute to the formation of smog, like we've had here the last few days. And finally, they contribute to acid precipitation problems.

Mr. McCURDY. The table we have on both ozone and on carbon monoxide is quite lengthy. I mean there's a significant number of areas, virtually every state has—

Mr. WILSON. Non-attainment areas, yes.

Mr. McCURDY.—non-attainment areas.

Mr. WILSON. And a lot more are going to have them, I think—

Mr. McCURDY. I'm sorry?

Mr. WILSON. A lot more, probably, as a result of the weather this summer. If you want to create ozone, what you need is a lot of hot, dry, windless days, and we're having that all over the country this year.

Mr. McCURDY. Well, I'm trying to understand—I think that's what we need to have clarified for the record too — is how these heavy-duty diesel engines contribute to that, and where we are in relation to meeting those standards. How difficult is it going to be to reach 0.25 on particulates for 1991? You've stated it in your record. I could categorize it as somewhat optimistic, maybe, or hopeful, that it will be attained. I'm not sure that the witnesses that follow will be as optimistic. Perhaps they will, but that's what I'd like to get on the record.

Mr. WILSON. Well, our optimism is based on the reviews that I mentioned, that we've gone out to each of the manufacturers and talked to them. Each one of them has a slightly different tilt they put on the odds of making the standard, but I think most are optimistic that they'll be able to meet the standard, 0.25 standard in 1991 without any add-on controls.

Mr. MCCURDY. What about the NO_x standard of 5.0?

Mr. WILSON. The NO_x standard of 5.0 isn't— shouldn't be a hinderance either to meeting the particulate standard. And it should be met too.

Like I said, we intentionally didn't push NO_x as hard as we could, in order to give some further assurance that the particulate reductions would be met.

Mr. MCCURDY. Since this is prospective, and not retroactive, what effect do you think this would have on the production of new engines and sales of new vehicles? Are people just going to delay and wait, or how do you see this moving?

Mr. WILSON. Well, I don't think that's going to happen. In a sense that's one reason we're pleased the engine industry has been able to cut down on engine-out emissions as much as it has, because those engines are going to be simpler in terms of air pollution control technology than we'd all envisioned. And in many ways, there are going to be significant improvements over the existing engines. The kind of technology that's being added to give better fuel control and add electronics to diesel engines are the kind of changes the car engines went through several years ago. And I think it will provide better engines for the users.

Mr. MCCURDY. Both bus and truck?

Mr. WILSON. Yes, both bus and truck. Bus, obviously, we picked bus engines for special treatment, so-to-speak, and required them to meet the tighter standards in 1991 for a number of reasons, including the fact that they're the one category of heavy-duty engines that spend all their time in the urban environment, and are most likely to be polluting the atmosphere around people. So they have a little tougher requirement. And as I mentioned in my testimony, it's possible that only the alternative-fueled engines, either methanol or compressed natural gas, will be available meeting those standards. There are provisions in the statute that provide for non-compliance penalties if there are technological laggards, and that's a method that could provide for the sale of non-complying diesel engines.

Mr. MCCURDY. I was interested in your statement on the sulfur control, the development of the fuel itself. You said shortcoming, or soon, or not too far in the distance. Can you pin that down a little more definitely, here?

Mr. WILSON. Well, we would hope before the end of the year to have a formal proposal out. As I mentioned, the most encouraging news is that the—I think, for particulate control the engine industry has basically recognized the need to control their particulate—has done, as I said, a fantastic job in controlling engine-out emissions so far, and has recognized, pointed out, the need to control sulfur, at least in diesel fuel.

I think the refining industry realized that that kind of control was inevitable, and those two industries have been meeting over

the last several weeks to try and work out, between them, a schedule for meeting the particulate standards and for lowering the sulfur in fuel. And we're pleased, obviously, with that sort of voluntary work, and I think that's going to make it easier for us to speedily get out some regulations in this.

Mr. McCURDY. But you expect a ruling this year?

Mr. WILSON. I expect at least a proposed ruling this year.

Mr. McCURDY. What is the status of the proposed rulemaking on methanol?

Mr. WILSON. We're very near completing the final rule, so it should be out in the next few weeks. We're going through final review process.

Mr. McCURDY. Why haven't you come forward with a proposal on natural gas, considering some of the very good evidence of low emissions, and clean fuel, and clean burning?

Mr. WILSON. We certainly agree that natural gas is a good alternative fuel, environmentally good alternative fuel. They're presently not covered by standards, so that in a sense they're unconstrained. They can produce engines. We don't have to promulgate standards for them where they can produce engines. Most of the natural gas vehicles have tended to be produced not by the engine manufacturers, but people will take an engine, a diesel or gasoline engine and convert it into a natural gas or propane engine.

We just haven't seen enough need, in terms of the numbers produced, and the emissions problems to go ahead and establish standards. It's really a resource question. It never kind of got to the point where we thought it was something worth spending time on versus a lot of other things we were doing.

Mr. McCURDY. Very good.

The gentleman from Maryland?

Mr. McMILLEN. I'm just curious if the deadline for ozone and carbon monoxide non-attainment is not pushed back by the Congress on August 31st, what will happen to the offending cities and counties?

Mr. WILSON. Well, last year Congress delayed sanctions that would occur for those areas. The kind of sanctions that come into place are stoppages of new facilities being built in an area, loss of federal grant money, highway money particularly. Those kinds of sanctions could come into place.

Furthermore, courts can require that the EPA promulgate standards for a local area, which is obviously difficult for the Federal Government to make those kinds of local decisions.

Mr. McMILLEN. And this, in all probability, will include another 30 or 40 more cities?

Mr. WILSON. Well, as we talked earlier, this is not a good year for ozone. We're getting high ozone readings all over the country this summer. So, it's likely there'll be more cities, not less in non-attainment.

Mr. McMILLEN. When you look at CO_2 being a primary contributor to the greenhouse effect, and the transportation sector contributing over 25 percent of that total, won't the production of methanol, especially from coal, add significantly to the CO_2 problem?

Mr. WILSON. It could. First of all, methanol vehicles produce less CO_2, not more than gasoline vehicles. So from the vehicle side, it's

better to burn methanol than it is to burn gasoline. The problem comes with the production side. You create less CO_2 producing gasoline than you do under the existing technology to produce methanol from coal. Most, really all methanol available today and that will likely be available for the next several years is produced from natural gas. That doesn't provide any greater CO_2 emissions than gasoline.

If you did start producing methanol from coal, you would produce more CO_2 emissions if you didn't include in that a requirement for those CO_2 emissions to be controlled at the plant that was producing methanol. That's certainly something, if we move to methanol as a transportation fuel in substantial quantities, we'd have to carefully work to make sure that control equipment was available to keep the production process from producing CO_2.

Mr. MCMILLEN. Are you concerned about the formaldehyde emissions?

Mr. WILSON. That's certainly something we're concerned about, and basically both ethanol and methanol, if were used as a pure fuel, tend to produce higher formaldehyde emissions than gasoline vehicles. That's why you'd have to have a catalytic converter on a methanol vehicle like you do on a gasoline vehicle. It would only have to be an oxidation catalyst, and those catalysts are very effective in removing formaldehyde, so we think it's a problem, but we think it's a problem that can easily be dealt with.

Mr. MCMILLEN. Just in closing, a few weeks ago there was a demonstration of a bus outside the Capitol. It might have been the Brooklyn Union Gas Company.

Mr. WILSON. It was the Brooklyn Union, yes. I think you'll hear more from them today.

Mr. MCMILLEN. It was very interesting. I just wondered why, in following up on the chairman's question, why the EPA has not moved further on this? I guess on the "expensive bus, cheap fuel," or the "cheap bus, expensive fuel" approach. I mean, you decided to take the methanol approach.

Mr. WILSON. Well, now we haven't decided to take the methanol approach. I think we took the approach of setting some pretty tight bus standards in 1991, to press the technology, both the technology for diesel and also to create hopefully a market for some of the alternative fuels. And we think both—New York City is a good example. We now have clean methanol buses, and clean natural gas buses operating in New York City. And we think comparing them to the relatively dirty diesel buses is a good way of demonstrating to the public what can be done in this area.

Mr. MCMILLEN. Thank you, Mr. Chairman.

Mr. MCCURDY. Thank the gentleman.

The gentleman from Pennsylvania?

Mr. WALKER. Thank you, Mr. Chairman.

I'd like to talk a little bit about your standards that you set for 1991 through 1994. What is going to be the cost to the industry for the more restrictive standards?

Mr. WILSON. We could get you, for the record, the cost that we estimated in the rulemaking when we promulgated it. Our estimates—basically our estimates assumed we would have to put trap

oxidizers on the engines, that cost around a thousand dollars a vehicle.

[A portion of the information to be furnished follows. For full report, see EPA Report A-80-18, "Regulatory Impact Analysis, Oxides of Nitrogen Pollutant Specific Study and Summary and Analysis of Comments," March 1985.]

3-31

Table 3-15

HDGE Manufacturer Costs for 1991 NOx Standard

	Undiscounted		Discounted*	
	RD&T	Hardware	RD&T	Hardware
1989**	3,524K	-	$4,264K	-
1990***	2,114K	-	2,325K	-
1991	-	2,770K	-	2,770K
1992	-	2,755K	-	2,505K
1993	-	2,770K	-	2,289K
	$5,638K	$8,295K	$6,589K	$7,564K
Total	$13,933K		$14,153K	

* 10 percent to 1991.
** Research and development costs.
*** Certification costs.

3-82

Table 3-34

HDDE Costs for Trap-Oxidizer Systems

Size Category	Ceramic Monolith/ Fuel Burner			Ceramic Monolith/ Electrical			Ceramic Fiber/Catalyst		
	Trap	System	Total	Trap	System	Total	Trap	System	Total
LHDDE	101	269	370	101	269	370	73	150	223
MHDDE	172	276	448	172	287	459	106	166	272
HHDDE	292	282	574	292	306	598	140	204	344

3-91

Table 3-37

Total HDDE Manufacturer Costs
1991 NOx and Particulate Standards

	Undiscounted		Discounted*	
	RD&T	Hardware**	RD&T	Hardware**
NOx	$28.7M	$42.3M	$34.8M	$38.5M
Particulate	49.5M	371.4M	63.4M	339.1M
Total	78.2M	413.7M	98.2M	377.6M
Grand Total	$491.9M		$475.9M	

* Discounted at 10 percent to 1991
** Model year 1991-93 HDDVs.

3-96

Table 3-40

HDDE Manufacturers' Cost
for the 1994 Particulate Standard

Year	Fixed Cost	Variable Cost	Undiscounted Total	Discounted Total
1990	$3.4 M	--	$ 3.4 M	$ 5.0 M
1991	9.8 M	--	9.8 M	13.0 M
1992	6.5 M	--	6.5 M	7.9 M
1993	2.9 M	--	2.9 M	3.2 M
1994	--	$56.0 M	56.0 M	56.0 M
1995	--	57.0 M	57.0 M	51.8 M
1996	--	57.9 M	57.9 M	47.8 M
Total			$193.5 M	$184.7 M

Mr. WALKER. And that would be the basic cost to the industry, is a thousand dollars per vehicle for the trap oxidizer?

Mr. WILSON. Yes, that's right.

Mr. WALKER. Does that cause loss of performance?

Mr. WILSON. It doesn't need to. One of the— what happens with the trap oxidizer is you have a filtering device that's collecting the particles, and periodically you need to burn those particles off, one way or another. If you don't burn them off, obviously, they'll build up back pressure and affect the performance of the vehicle.

Mr. WALKER. I guess my question really goes, is have you also assessed the overall economic impact of what you're doing beyond just the cost to the industry of putting on the trap oxidizer? Has there been an assessment done by EPA of the overall economic impact of the new restrictions?

Mr. WILSON. Yes. We did it as part of our promulgation of the standards, fuel economy effects and the like.

Mr. WALKER. Okay.

And what was the impact on the GNP?

Mr. WILSON. I don't remember the total number, but I'd be happy to provide it.

Mr. WALKER. Would you get that for us for the record?

Mr. WILSON. Oh, sure.

Mr. WALKER. Okay.

[Information referred to follows:]

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8. Aggregate Costs to the Nation of the HDE NOx and Particulate Standards

The aggregate costs to the nation of the HDE NOx and particulate standards include the total manufacturer costs of RD&T and hardware, and user costs of fuel economy and maintenance which will be incurred due to the more strict emission control requirements of the standards. These costs were developed above, and are shown in Tables 3-42 and 3-43 according to the year of expenditure. All costs before the year of the standard are for RD&T, including certification, and costs after the year of the standard are for hardware and additional operating costs for the vehicles equipped with HDEs projected to be sold in those years.

The aggregate costs presented in Tables 3-42 and 3-43 for each model year group are incremental in nature. The aggregate incremental costs for the 1991 model year group represent only the added costs beyond those incurred in the 1988 model year group. The same is true in considering the 1994 model year group aggregate costs, with the exception that the increment is calculated relative to 1991.

All costs are shown undiscounted in Table 3-42 and discounted at 10 percent to the year of the standard in Table 3-43 and are developed in the preceding sections. As shown, the aggregate costs to the nation of the HDE NOx and particulate standards are approximately $118-600 million for the 1988 standards, $833-1,241 million for the 1991 standard, and $336-394 million for the 1994 particulate standards, discounted to each of those years.

Taken from EPA Report A-80-18, "Regulatory Impact Analysis, Oxides of Nitrogen Pollutant Specific Study and Summary and Analysis of Comments," March 1985.

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Table 3-42

Undiscounted Aggregate Incremental Costs of the HDE Standards

(millions of dollars)

Model Year 1988

Calendar Year	HDDE NOx	HDDE Particulate	HDGE NOx	HDE Total
1986	$18.0	$16.0	$1.6	$35.6
1980	12.7	7.0	2.1	21.8
1988	10.8-246.0	5.9	1.3	18.0-253.2
1989	11.2-195.5	6.2	1.3	18.7-203.0
1990	11.7-107.5	6.4	1.3	19.4-115.2

Model Year 1991

Calendar Year	HDDE NOx	HDDE Particulate	HDGE NOx	HDE Total
1987	-	$8.0	-	$8.0
1988	$7.0	20.0	-	27.0
1989	15.0	14.0	$3.5	32.5
1990	6.7	7.5	2.1	16.3
1991	13.7-146.6	253.9-299.8	2.8	270.4-449.2
1992	14.2-117.8	253.0-298.6	2.8	270.0-419.2
1993	14.4-84.5	239.8-282.4	2.8	259.0-369.7

Model Year 1994

Calendar Year	HDE Particulate
1990	$3.4
1991	9.8
1992	6.5
1993	2.9
1994	110.4-131.3
1995	112.3-133.6
1996	114.2-135.7

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Table 3-43

Discounted* Aggregate Incremental Costs of the HDE Standards
(millions of dollars)

Model Year 1988

Calendar Year	HDDE NOx	HDDE Particulate	HDGE NOx	HDE Total
1986	$21.8	$19.4	$1.9	$43.1
1987	14.0	7.7	2.3	24.0
1988	10.8-246.0	5.9	1.3	18.0-253.2
1989	10.2-177.7	5.6	1.2	17.0-184.5
1990	9.7- 88.8	5.3	1.1	16.1- 95.2
Total	$66.5-548.3	$43.9	$7.8	$118.2-600.0

Model Year 1991

Calendar Year	HDDE NOx	HDDE Particulate	HDGE NOx	HDE Total
1987	--	$11.7	-	$11.7
1988	$9.3	26.6	-	35.9
1989	18.2	16.9	$4.3	39.4
1990	7.4	8.2	2.3	17.9
1991	13.7-146.6	253.9-299.8	2.8	270.4-449.2
1992	12.9-107.1	230.0-271.4	2.5	245.4-381.0
1993	11.9- 69.8	198.2-233.4	2.3	212.4-305.5
Total	$73.4-358.4	$745.5-868.0	$14.2	$833.1-1240.6

Model Year 1994

Calendar Year	HDE Particulate
1990	$5.0
1991	13.0
1992	7.9
1993	3.2
1994	110.4-131.3
1995	102.0-121.3
1996	94.3-112.1
Total	$335.8-393.8

* 10 percent to the year of the standard.

Mr. WALKER. What tend to be the economic advantages and disadvantages of the new emissions standards?

Mr. WILSON. Well, the economic advantages of these standards, I guess, are a decrease in the public health problems that are created by those particulates. As I mentioned, especially the diesel particulates tend to be very, very small particles, and it's the small particles that tend to get past the barriers in the nose and into the lungs and create health problems. And several animal studies have indicated those particles are carcinogenic at high enough levels. So the economic benefits tend to be in the area of health improvements, and also in the area of some welfare effects, lower soiling and the like.

And obviously, the economic costs are the cost of adding that control technology.

Mr. WALKER. There are no other economic disadvantages other than the cost of adding the control technology in the studies that you've done?

Mr. WILSON. No. With some of the add-on devices you can get slightly lower fuel economy, so that's also a cost we look at.

Mr. WALKER. So, okay.

There is a loss of fuel economy, so there's a loss of efficiency?

Mr. WILSON. There can be depending on the device.

Mr. WALKER.So for your transportation system for your basically commercial transportation system utilizing trucks, buses obviously in the city, but primarily your trucks in your interstate system, you do have the potential economic impact of reduced performance, reduced efficiency, and the impact that that brings to the economy as a whole, is that right?

Mr. WILSON. Oh, that's certainly possible.

Mr. WALKER. And all those things have been weighed in EPA studies at this point?

Mr. WILSON. Well, they have been weighed in EPA studies.

Mr. WALKER. And you can provide, for the record, a relative balance between the public health benefits and the savings that we are going to achieve there, as compared to the cost to the transportation system that would be involved in making this decision?

Mr. WILSON. Yes.

Mr. WALKER. I think that that would be useful for us to have for the record, so that we can see the process that was used for deciding to move in that particular direction.

[Information referred to follows:]

Taken from EPA Report A-80-18, "Regulatory Impact Analysis, Oxides of Nitrogen Pollutant Specific Study and Summary and Analysis of Comments," March 1985.

a. Non-Cancer Health Effects

Particulate matter in general has long been regarded as hazardous to human health. EPA recognized this danger and established an NAAQS for total suspended particulate (TSP) as early as 1971. As discussed in Section II, EPA has proposed an ambient standard that will focus on inhalable particles (i.e., those with diameters of 10 microns or less (PM_{10})), because it is this fraction that appears to be responsible for most of the human health effects associated with TSP.

As mentioned earlier, diesel particulates fall easily into the PM_{10} category, as the majority are classified as fine particulate (less than 2.5 microns in diameter). Although a large body of data has been developed regarding the health effects of inhalable particulate matter, research limited specifically to diesel particulate is relatively new and somewhat inconclusive. An analysis of the available data indicates that, until more is known, diesel particulate generally should be regarded as being equivalent to other forms of inhalable particulate matter in terms of the hazard it presents to human health, although there is a possibility it may be somewhat more hazardous.[5] It should be pointed out, however, that even if regarded as posing the same hazard, diesel particulate is emitted directly into the breathing zone, rather than from tall stacks that would promote dispersion. Thus, the potential for human exposure is maximized.

Two basic concerns exist with respect to the health risk posed by inhalable particulate in general. First, inhalable particulates are small enough so that they are not as readily prevented by the natural body defenses from reaching the lower respiratory tract, as would coarser particles. Fine particulate matter can penetrate to the alveoli, or deepest recesses of the lungs, where the oxygen/carbon dioxide exchange takes place with the circulatory system.[29] The body requires months or years to clear foreign matter from the alveolar region, as opposed to hours or days to clear the upper respiratory system. The second concern is that inhalable particulate may be composed of toxic materials or may have hazardous materials adsorbed onto its surface.

The most obvious non-cancer health effect of an inhalable particulate, such as that produced by diesels, is injury to the surfaces of the respiratory system, which could result in reduced lung function, bronchitis or chronic respiratory symptoms. The hazardous chemicals that may be associated with particulate matter (e.g., organic compounds, lead, antimony,

etc.) can either react with lung tissue or be transported to other parts of the body by the circulatory system. Particulate matter may also weaken the resistance of the body to infection and there are indications that it reacts adversely in conjunction with other atmospheric pollutants. For example, studies in London, New York, Buffalo, and Nashville have found an increase in the mortality rate, especially among older persons, when high particulate levels were accompanied by high sulfur dioxide levels.[30]

From the above discussion, it is clear that inhalable particulate matter (PM_{10}) has been linked directly with a myriad of adverse non-cancer health effects, and it is based on this information that EPA has proposed the NAAQS for PM_{10}. Also, diesel particles are all inhalable particulate and, therefore, can potentially represent the same concern. This relationship can be used to assess the overall benefits of controlling HDDV diesel particulate.

As stated in the Draft RIA for the PM_{10} NAAQS, 105-329 counties are projected to be in non-attainment of the range of primary PM_{10} standards being considered for 1989.[26] Even after reasonable non-mobile source emission controls are implemented, numerous violations of the NAAQS are still projected to occur. As shown in Table 4-9, if no further HDDV controls were implemented, annual average exposure to diesel particulate for urban dwellers would be at a level of approximately 5.5 ug/m^3 in the year 2000, or about 10 percent of the suggested PM_{10} NAAQS. Promulgation of the HDDV standards is projected to reduce this exposure to about 3.0 ug/m^3, therefore playing an important role in reducing urban PM_{10} exposure. Furthermore, the resulting reduction in diesel particulate emissions within urban areas that continue to violate the suggested PM_{10} NAAQS will directly reduce the non-cancer health effects associated with inhalable particulates in general.

b. Carcinogenic Health Effects

A number of studies have concluded that exposure to diesel particulate probably poses an additional risk of acquiring lung cancer. EPA surveyed these studies and developed scenario-specific risk factors for lung cancer incidence, taking into account the relative reduction of compounds producing the cancer-risk with respect to reductions in total diesel particulate.[5] Table 4-10 shows the resultant cancer risk estimates associated with diesel particulate for both the base-case and the controlled-case scenarios along with estimated risks from other known carcinogens, shown for purposes of comparison.

The data indicate that while the risk of contracting lung cancer is greatest from smoking, exposure to diesel particulate may represent a significant portion of all non-smoking-related lung cancer. The upper limit of the uncontrolled (base) scenario in 2000 would represent almost eight individuals in a million, or 10 percent of all non-smoking-related lung cancer in the U.S. The lower limit still represents over one in a million individuals, which has been used in the past by regulatory agencies as a cut-off point for determining the need for control. Thus, as indicated in the NPRM, Table 4-10 shows that a relatively small but significant cancer risk may be attributable to diesel particulate exposures. The promulgated HDDV controls are estimated to reduce this risk by almost one-half in the year 2000.

c. Visibility Effects

Reduced visibility is one of the more readily apparent effects of diesel particulate. Because diesel particles are of a diameter most effective in scattering light and their 65-80 percent carbon content produces a high degree of light absorption, visibility reduction results.

Table 4-11 presents the estimated visibility impacts of the base- and controlled-case scenarios in terms of the average percent reduction due to diesel particulates in 1995 and 2000 urban visibility from early 1970's levels. As shown, in the absence of controls, increases in diesel particulate levels will result in reduced visibility, ranging from a 22 percent reduction in largest cities, to 4-9 percent decreases for less populous urban areas in the year 2000. HDDV control is projected to cut these visibility reductions to 12 percent in the largest cities, and to 2-5 percent in smaller urban areas. The controlled-case scenario thus offers a 2-10 percent improvement in visibility over the base-case scenario, depending on the size of the city. The lower limit of this impact (i.e., the effect for smaller cities), may not be perceptible. However, the effect for large cities would show a noticeable improvement in visibility. The promulgated standards, therefore, will provide an overall benefit that would be most apparent in the areas where it was most needed.

d. Soiling Effects

In a review of the scientific literature, the DPS[5] found some evidence suggesting that because of its black color and oily nature, diesel particulate may have a disproportionate effect on soiling compared to the effect of other types of particulate (i.e., diesel particulate would produce more soiling than TSP on a gram-for-gram basis). The black color may make the soiling more apparent to the observer and the oily

nature may make it more difficult to clean. The net effect would be to increase costs to the general public for more frequent and more thorough cleaning events. However, because of the paucity of scientific data on the physical soiling effects of diesel particulate and TSP, no definitive statement of these relationships can be made at this time.

There is a somewhat larger body of literature available regarding the costs associated with various levels of soiling. Summaries of this economic literature can be found in an EPA report regarding the benefits associated with diesel particulate control,[31] and in the Draft RIA. These reports conclude that there are significant economic benefits to be gained from control of diesel particulates with respect to soiling.

4. Conclusions

Based on the above projections, EPA believes that diesel particulate emissions are a serious environmental concern with respect to their impact on various health and welfare aspects. It seems apparent that significant reductions in heavy-duty diesel emissions are an essential element in dealing with this environmental problem. The stringent controls on heavy-duty diesels and urban buses being promulgated in the final rule are viewed as effective means of reducing the future growth in particulate emissions.

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Table 4-9

Effect of Diesel Particulate Control on Urban Air Quality*

	Total Diesel Particulate Concentration (ug/m^3)				
		1995**		2000**	
	1984	Base	Controlled	Base	Controlled
Ambient Urban Concentrations* **					
City Population:					
Greater than 1,000,000	1.3-3.0	2.3-5.5	1.5-3.6	2.9-6.8	1.6-3.7
500,000 - 1,000,000	0.8-2.0	1.5-3.6	1.0-2.4	2.0-4.6	1.1-2.5
250,000 - 500,000	1.0-1.6	1.8-3.0	1.2-2.0	2.2-3.7	1.2-2.0
100,000 - 250,000	0.7-1.7	1.2-3.2	0.8-2.1	1.5-4.0	0.8-2.2
Annual Average Exposure to U.S. Urban Dwellers					
TOTAL	2.4	4.4	2.9	5.5	3.0
Microscale Concentrations					
Roadway Tunnel:					
Typical	63	91	60	105	57
Severe	159	231	152	266	145
Street Canyon:					
Typical	2	3	2	4	2
Severe	16	23	15	26	14
On Expressway:					
Typical	7	11	7	11	6
Severe	28	41	27	48	26
Beside Expressway	6	9	6	9	5

* Based on best-estimate projections.
** Control effectiveness is approximately 35% in 1995 and 46% in 2000.
*** Ranges are average values plus and minus one standard deviation.

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Table 4-10

Comparison of Risks from Various Sources

Sources of Risk	Estimated Annual Risk (risk/person-year)	Exposed Population
Commonplace Risks of Death		
Motor Vehicle Accident	222.0×10^{-4}	Entire U.S.
Drowning	26.0×10^{-4}	Entire U.S.
Burns	21.0×10^{-4}	Entire U.S.
Tornados, Floods, Lightning, Hurricanes, etc.	2.0×10^{-4}	Entire U.S.
Risks of Cancer Incidence		
Diesel Particulate (1995):		Urban U.S.
Base Scenario	$1.2 \times 10^{-4} - 6.2 \times 10^{-4}$	
Controlled Scenario	$0.8 \times 10^{-4} - 4.1 \times 10^{-4}$	
Diesel Particulate (2000):		Urban U.S
Base Scenario	$1.5 \times 10^{-4} - 7.7 \times 10^{-4}$	
Controlled Scenario	$0.8 \times 10^{-4} - 4.2 \times 10^{-4}$	
Natural Background Radiation (sea level)	20.0×10^{-4}	Entire U.S.
Average Diagnostic Medical X-Rays in the U.S.	20.0×10^{-4}	Widespread
Frequent Airline Passenger (4 hours per week flying)	10.0×10^{-4}	Limited
Four Tablespoons Peanut Butter Per Day (due to presence of aflatoxin)	8.0×10^{-4}	Fairly Widespread
Ethylene Dibromide	4.2×10^{-4}	Widespread
One 12-Ounce Diet Drink Per Day	2.6×10^{-4}	Widespread
Arsenic	1.7×10^{-4}	1% of U.S.
Miami or New Orleans Drinking Water (due to presence of chloroform)	1.0×10^{-4}	Southern U.S., Urban
Lung Cancers:		Entire U.S.
For Smokers Due to Smoking	419.0×10^{-4}	
For General Population Due to Causes Other Than Smoking	73.9×10^{-4}	

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Table 4-11

Average Reduction in Visibility
Due to Diesel Particulate
(percent reductions from base-year visibility)

City Size (population)	1995		2000	
	Base	Controlled	Base	Controlled
More than 1,000,000	18	12	22	12
500,000-1,000,000	7	5	9	5
250,000-500,000	5	3	7	4
100,000-250,000	3	2	4	2

Mr. WALKER. Does the industry today, in your mind, have sufficient technology, state-of-the-art technology, to meet the standards that you have set for 1991 to 1994, or is new technology going to have to be developed?

Mr. WILSON. Well, we think there is—they have technology to meet the 1991 standards; they don't have the technology in hand yet to meet the 1994 standards, although with fuel sulfur control, and with the job they've been able to do to date on cutting down the basically carbon emissions from the engine, that makes even the 1994 standards easier than we originally expected, and opens the door for technology such as catalytic devices which would be cheaper and easier to maintain than traps, or traps with catalysts that wouldn't require expensive regeneration techniques.

So 1994 is the—most of their efforts have been to meet 1991. I think they feel relative comfortable they now have in hand a way to do that. Once they've finished that job, they'll—

Mr. WALKER. That's the trap oxidizer?

Mr. WILSON. No, no, that's controlling engine-out emissions. That's adding electronics, adding better fuel control. It's having better control over the combustion process in the engine. Through that and through fuel sulfur reductions, I think they expect to be able to meet the 1991 standards. And then they're going to be turning their attention more to the 1994 standards, and we're more optimistic, I guess, than we were when we promulgated the standards that those will be met too.

Mr. WALKER. Well, there are some people, within the automotive industry, or basically within the truck business, who have indicated that these standards could likely kill off the diesel motor as an alternative. I mean, is that, in your mind, a likely result of what we're doing here?

Mr. WILSON. No, I don't think so. As I said, all the indications we have are that the engine industry has taken seriously the need to control particulates, especially from its engines, and is doing a remarkable job in achieving that. So, as I said, we're more optimistic than we were when we promulgated those technology-forcing standards. Probably they are too.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. MCCURDY. Thank the gentleman.

One last question, Mr. Wilson. As you know, the Department of Energy has on-going programs for heavy-duty transports and alternative fuels. Are these programs helping to solve the emissions problems, and are they doing enough?

Mr. WILSON. Well, A, they are helpful, and we stay close touch with the people in DOE. Their programs tend to be a little longer term than we tend to be looking, so I think some of the work they're doing with ceramics, and adiabatic engines, and turbines are years down the road as opposed to the sort of short-term levels that we in the engine industry are looking at. But it's important to do that, and yes, in the long run it contributes.

Mr. MCCURDY. There is coordination and cooperation between the two?

Mr. WILSON. Yes.

Mr. MCCURDY. Very good.

Thank you for your appearance today.

Mr. WILSON. Thank you.

Mr. MCCURDY. The next witnesses will be on a panel. We welcome Mr. John Fisher, who is the Manager of the Emissions Certification of Detroit Diesel Corporation; Mr. James Boyd, who is the Executive Officer of the California Air Resources Board; Mr. LeRoy Bailey, Assistant General Manager for Bus Service of the Washington Metropolitan Area Transit Authority; and, Mr. Craig Matthews, Group Senior Vice President and Chief Financial Officer of the Brooklyn Union Gas Company, Brooklyn, New York.

Gentlemen, welcome. We appreciate you're appearing here today, and certainly appreciate Mr. Fisher for making a special effort to come at the last minute.

Your complete testimony and the statements that we have are admitted into the record in their entirety, and you may summarize or cover it in any way you want, or hit particular items that perhaps Mr. Wilson's comments may have raised in your own mind. We'll start with Mr. Fisher, and then Mr. Boyd, Mr. Bailey, and Mr. Matthews.

Mr. Fisher.

STATEMENT OF MR. JOHN FISHER, DETROIT DIESEL CORPORATION, DETROIT, MICHIGAN

Mr. FISHER. Thank you, Mr. Chairman, and members of the committee. My name is John Fisher. I am Manager of Emission Certification for Detroit Diesel Corporation.

Before addressing the issues, let me characterize the Detroit Diesel Corporation. Detroit Diesel was formed, recently, as a result of a recent joint venture between General Motors Corporation and the Penske Corporation to design, manufacture, and sell heavy-duty diesel engines. Detroit Diesel is a worldwide manufacturer of diesel engines in the 50 to 2000 horsepower range for the heavy-duty truck, bus, defense, marine, industrial, and construction markets. Typical automotive applications of our engines are in trucks manufactured by Volvo GM, Freightliner, Kenworth, Peterbilt, Ford, in buses manufactured by TMC, Flxible, Neoplan, Gillig for transit coach applications, and for intercity coaches made by TMC, Eagle and Prevost.

Also, I'd like to explain our corporate philosophy on the role of Government and industry with regard to emission standards. Detroit Diesel believes that Government's role should be to set standards which properly take into consideration real environmental and health needs, which are achievable and cost effective. It is industry's role to develop the technology to meet these standards in the required time frame. Therefore, Detroit Diesel is here to share with you the technologies that are being developed and issues that need to be resolved which should enable Detroit Diesel to meet the 1991 and 1994 heavy-duty truck and bus emission standards.

I'd like to focus on four issues as they apply to heavy-duty diesel engines. These issues are: one, the 1991 heavy-duty truck engine standards; two, the 1991 urban bus standards; three, 1994 heavy-duty engine standards; and finally, the feasibility of more stringent heavy-duty standards beyond what EPA has promulgated for 1994.

The emission regulations promulgated by EPA for 1991 trucks were intended to force the development of advanced emission control technology. These standards are technology forcing, requiring engine manufacturers to develop technologies to meet the standards which will satisfy our customer's needs and enable us to remain competitive. I'm sure it's not necessary to review these new standards, as Mr. Wilson did so earlier, but I will say the real difficulty lies with the particulate standard. These tougher emission standards cannot be met with engine changes alone. The reduction from 0.6 gram per brake horsepower-hour in 1988 to 0.25 gram per brake horsepower-hour in 1991 will require a major effort on all parties involved, and that includes us as engine manufacturers, the vehicle manufacturers, and the oil industry.

Detroit Diesel has responded to these challenges and now anticipates that the 1991 heavy-duty engine particulate standard for trucks can be met without aftertreatment devices. The engine technology Detroit Diesel is developing to aid in achieving these standards includes engine modifications such as higher injection pressures, improved lubricating oil control, injection timing and air system flexibility through electronic engine controls, and air-to-air charge cooling. Detroit Diesel envisioned the need for this flexibility through electronic controls in 1980 and initiated the Detroit Diesel Electronic Engine Control Program which is now in production. In order to meet these standards, vehicle manufacturers will be required to make vehicle modifications such as interfacing with the engine electronics and enhanced air systems and the oil industry will be required to improve diesel fuel quality.

Improving diesel fuel quality by lowering fuel sulfur content to 0.05 percent maximum will be required to achieve the 1991 standards. In an effort to achieve this, the Engine Manufacturers Association has been meeting with members of the oil industry and are working on resolving this issue.

In addition to these requirements, we believe regulatory flexibility, such as non-conformance penalties, emission averaging, and banking and trading of emission credits should be made available. A manufacturer would then have flexibility to continue to produce an engine not in compliance until the engine can be modified to meet the stringent 1991 standards.

Detroit Diesel believes that with low sulfur fuel and improved engine technology, the 1991 heavy-duty truck engine standards will be achieved with our automotive products. However, should any engines not meet the standard, they will be close and should still be available for sale using non-conformance penalties and other regulatory strategies.

Now let me turn to the 1991 urban bus issue. The emission regulations set by EPA for 1991 urban buses of 0.1 gram per brake horsepower-hour versus the 0.25 truck standard were established on the basis of particulate trap technology becoming available. The standards achieved their purpose of accelerating the development of aftertreatment devices. However, today particulate traps have not been developed to the stage where they will be ready for production.

Detroit Diesel embarked on another strategy to insure that we could provide the customer an engine that met the anticipated re-

quirements. This included the use of alternative fuels to meet these low particulate levels. Methanol was selected as the alternative fuel which had the potential of providing low NO_x as well as meeting the urban bus particulate standard. We now have experimental methanol engines that have emission levels below the 1991 standards and have 17 similar methanol engines running in California, New York, Florida and Canada, with another 37 scheduled to go into operation later this year. We plan to introduce this engine as a production engine for sale in late 1990.

However, we are finding understandable concern about the use of methanol in urban buses for a variety of reasons. Methanol use in a heavy-duty engine is a new and untried technology. The future cost of methanol is unknown. A methanol fuel distribution network needs to be established along with preparing bus properties to fuel and maintain these buses. Other concerns which need to be addressed are unregulated emissions and safety.

Detroit Diesel's position is to be prepared to provide engines for urban buses using existing capital equipment. As we currently see the situation, Detroit Diesel would like to offer both a diesel-fueled engine and a methanol-fueled engine for the 1991 urban buses. To enable a diesel-fueled engine to be available, a better quality diesel fuel and non-conformance penalties will be required.

The emission standards promulgated for 1994, the 0.1 particulate standard along with the 5.0 gram NO_x standard are technology-forcing and we believe are representative of the lowest levels achievable with a diesel-fueled compression-ignition engine. The 1994 particulate standard will require us to have multiple control strategies, for example, engine and fuel modifications with aftertreatment such as particulate traps, or possibly catalytic converters, or methanol.

Detroit Diesel is conducting particulate trap development and is also participating in a joint industry effort with the Engine Manufacturers Association targeted at developing and evaluating diesel particulate control systems. Development efforts to date have shown that NO_x and particulate levels can be reduced to the 1994 standards on experimental systems.

However, there are difficult issues remaining which need to be solved before it is known if these are feasible production systems. These include durability, reliability, and the achievement of the lowest practical cost of the aftertreatment system. In the case of a heavy-duty diesel engine, EPA requires the engine to comply with the standards for a period of 290,000 miles and the engine actually operates for a period much longer than that in a typical heavy-duty truck application. With a particulate standard of only 0.1, durability becomes a critical issue.

Methanol may also emerge as a technology used to meet the 1994 standards. The use of methanol in fleets which rely on central fueling locations, such as refuse and municipal trucks, may find methanol more desirable and less costly than exhaust aftertreatment devices.

Regarding further emission reductions, several bills have been brought before the House and Senate which call for emissions reductions more stringent than those already established by the EPA. These bills would require further NO_x reduction in addition

to the stringent 1994 particulate standard. In Detroit Diesel's opinion, the emission standards that EPA has already set represent the lowest level known today that can be achieved by a diesel-fueled engine. We feel standards which are more stringent than those anticipated for 1994 would require alternative fuels in the marketplace. Indeed, the 1994 standards may achieve the same result.

In conclusion, I would like to say that Detroit Diesel sees the 1991 and 1994 standards as a formidable challenge and we are working hard to meet these standards. Detroit Diesel Corporation desires to continue to sell heavy-duty engines and to receive an adequate return on our capital and investment.

On behalf of Detroit Diesel Corporation, thank you for giving me the opportunity to discuss these issues with the subcommittee.

[The prepared statement of Mr. Fisher follows:]

STATEMENT OF DETROIT DIESEL CORPORATION

ON

TRUCK AND BUS POLLUTION

TO

THE TRANSPORTATION, AVIATION AND MATERIALS SUBCOMMITTEE

OF

THE HOUSE SCIENCE, SPACE, AND TECHNOLOGY COMMITTEE

WASHINGTON, DC

JULY 13, 1988

Mr. Chairman and members of the Committee, my name is John Fisher, I am Manager, Emission Certification for Detroit Diesel Corporation.

Before addressing the issues, let me characterize the Detroit Diesel Corporation. Detroit Diesel was formed as the result of a recent joint venture between General Motors Corporation and the Penske Corporation to design, manufacture, and sell heavy-duty diesel engines. Detroit Diesel is a worldwide manufacturer of diesel engines in the 50 to 2000 hp range for the heavy-duty truck, bus, defense, marine, industrial, and construction markets. Typical automotive applications of our engines are in trucks manufactured by Volvo GM, Freightliner, Kenworth, Peterbilt, Ford, in buses manufactured by TMC, Flxible, Neoplan, Gillig for transit coach applications, and for intercity coaches made by TMC, Eagle, and Prevost.

Also, I would like to explain our Corporate philosophy on the role of government and industry with regard to emission standards. Detroit Diesel believes that government's role should be to set standards which properly take into consideration real environmental and health needs, which are achievable and cost effective. It is industry's role to develop the technology to meet the standards in the required time frame.

Therefore, Detroit Diesel is here to share with you the technologies that are being developed and issues that need to be resolved which should enable Detroit Diesel to meet the 1991 and the 1994 heavy-duty truck and bus emission standards.

I would like to focus on four issues as they apply to heavy-duty diesel engines. These issues are:

1) 1991 heavy-duty truck engine standards, 2) The 1991 urban bus standards, 3) 1994 heavy-duty engine standards, and 4) the feasibility of more stringent heavy-duty standards beyond 1994.

The emission regulations promulgated by EPA for 1991 trucks were intended to force the development of advanced emission control technology. These standards are technology forcing, requiring engine manufacturers to develop technologies to meet the emission standards, which will still satisfy our customer needs, and enable us to remain competitive. I am sure it is not necessary to review these new standards, but I will say that the real difficulty lies with the particulate standard. These tougher emission standards cannot be met with engine changes alone. The reduction from 0.6 g/bhp-hr in 1988 to 0.25 g/bhp-hr requires a major effort on the part of all parties involved, the engine manufacturers, vehicle manufacturers, and the oil companies.

Detroit Diesel has responded to these challenges and now anticipates that the 1991 heavy-duty engine particulate standard for trucks can be met without aftertreatment devices. The engine technology Detroit Diesel is developing to aid in achieving these standards includes engine modifications such as higher injection pressures, improved lubricating oil control, injection timing and air system flexibility through electronic engine controls, and air-to-air charge cooling. Detroit Diesel envisioned the need for this flexibility through electronic controls in 1980 and initiated the Detroit Diesel Electronic Engine Control Program which is now in production. In order to meet these standards, vehicle manufacturers will be required to make vehicle modifications such as interfacing with the engine electronics and enhanced air systems and the oil industry will be required to improve diesel fuel quality.

Improving diesel fuel quality by lowering fuel sulfur content to 0.05% maximum will be required to achieve the 1991 standards. In an effort to achieve this, the Engine Manufacturers Association has been meeting with members of the oil industry and working towards resolving this issue.

In addition to these requirements, regulatory flexibility, such as nonconformance penalties, emission averaging, and banking and trading of emission credits should be made available. A manufacturer would then have flexibility to continue to produce an engine not in compliance until the engine can be modified to meet the stringent 1991 standards.

Detroit Diesel believes that with low sulfur fuel and improved engine technology, the 1991 heavy-duty truck engine standards will be achieved with our automotive products. However, should any engines not meet the standard, they will be close and should still be available for sale using nonconformance penalties and other regulatory strategies.

Now let me turn to the 1991 urban bus issue. The emission regulations set by EPA for 1991 urban buses of 0.1 g/bhp-hr versus the 0.25 truck standard were established on the basis of particulate trap technology becoming available. The standards achieved their purpose of accelerating the development of aftertreatment devices. However, today particulate traps have not been developed to the stage where they will be ready for production.

Detroit Diesel embarked on another strategy to insure that we could provide the customer an engine that met the anticipated requirements. This included the use of alternative fuels to meet these low particulate levels. Methanol was selected as the alternative fuel which had the potential of providing low NOx as well as meeting the urban bus particulate standard. We now have experimental methanol engines that have emission levels below the 1991 standards and have 17 similar methanol engines running in California, New York, Florida, and Canada, with another 37 scheduled to go into operation later this year. We plan to introduce this engine as a production engine for sale in late 1990.

However, we are finding understandable concern about the use of methanol in urban buses for a variety of reasons. Methanol use in a heavy-duty engine is a new and untried technology. The future cost of methanol is unknown. A methanol fuel distribution network needs to be established along with preparing bus properties to fuel and maintain these buses. Other concerns which need to be addressed are unregulated emissions and safety.

Detroit Diesel's position is to be prepared to provide engines for urban buses using existing capital equipment. As we currently see the situation, Detroit Diesel will offer both a diesel-fueled engine and methanol-fueled engine for 1991 urban buses. To enable a diesel-fueled engine to be available, a better quality diesel fuel and nonconformance penalties will be required.

The emission standards promulgated for 1994 are technology forcing and we believe are representative of the lowest levels achievable with a diesel-fueled compression-ignition engine. The 1994 particulate standard will require us to have multiple control strategies, for example; engine and fuel modifications with particulate traps, or catalytic converters, or methanol with a catalytic converter.

Detroit Diesel is conducting particulate trap development and is also participating in a joint industry effort with the Engine Manufacturers Association targeted at developing and evaluating a diesel particulate control system. The development efforts to date have shown that the NOx and particulate levels can be reduced to the 1994 standards on experimental systems.

However, there are difficult issues remaining which need to be solved before it is known if these are feasible production systems. These include durability, reliability and the achievement of the lowest practical cost of the aftertreatment system used. In the case of a heavy-duty diesel engine, the engine is expected to comply with the standards for a period of 290,000 miles and operate for a period much longer than this. With a particulate standard of only 0.10 g/bhp-hr, durability becomes a critical issue.

Methanol may also emerge as a technology used to meet the 1994 standards. The use of methanol in fleets which rely on a central fueling location, such as refuse and municipal trucks, may find methanol more desirable and less costly than exhaust aftertreatment devices.

Regarding further emission reductions, several bills have been brought before the House and Senate which call for emission reductions more stringent than those already established by the EPA. These bills would require further NOx reduction in addition to the stringent 1994 particulate standard. In Detroit Diesel's opinion, the emission standards that EPA has already set represent the lowest level known today that can be achieved by a diesel-fueled engine. We feel standards which are more stringent than those established for 1994 could require alternative fuels in the marketplace. Indeed, the 1994 standards may achieve the same result.

In conclusion, I would like to say that Detroit Diesel sees the 1991 and 1994 standards as a formidable challenge and we are working hard to meet these standards. Detroit Diesel Corporation desires to continue to sell heavy-duty engines and to receive adequate return on our capital and investment.

On behalf of the Detroit Diesel Corporation, thank you for giving me the opportunity to discuss these issues with the Subcommittee.

Mr. McCURDY. Thank you, Mr. Fisher.

We'll hear next from Mr. Boyd, and the other panel members and we'll have questions after their testimony.

Mr. Boyd.

STATEMENT OF MR. JAMES D. BOYD, EXECUTIVE OFFICER, CALIFORNIA AIR RESOURCES BOARD, SACRAMENTO, CALIFORNIA

Mr. BOYD. Thank you, Mr. Chairman.

And thank you very much for the invitation to appear here, which brings with it recognition of the fact that California and the California Air Resources Board indeed do play a role in this area of vehicle emissions and heavy-duty, and we appreciate that recognition from the other side of the continent.

I'm certainly pleased to be here to speak to you about our efforts to control emissions from heavy-duty trucks and buses. And as you indicated, and as I was confident, Mr. Wilson covered the total spectrum of heavy-duty vehicles and the standards, and what-have-you, and I anticipated that, and you can see from the title of my presentation, I am going to be emphasizing diesels and diesel vehicles.

Although the diesel vehicle population is quite small in comparison to gasoline, diesels do contribute significantly to California's air quality problems. Emissions of particulate matter and oxides of nitrogen, that you've heard so much about already this afternoon, are most readily associated with diesels, and of the two, particulate matter or smoke is certainly the most objectionable to the public, but indeed carries with it public health and welfare concerns. This is particularly true of heavy-duty diesel vehicles which emit levels of smoke and soot twenty times that of a comparably-sized gasoline vehicle.

So today, I'm going to review the Air Resources Board's on-going emission control efforts for heavy-duty diesel trucks and buses. And I'm going to discuss the standards, the use of cleaner fuels, the inspection of in-use diesel vehicles, diesel toxic emissions, various research projects funded by the ARB to encourage the use of new technology, and offer a comment or two on industry's efforts to meet our clean air, our public health needs in the State of California.

There are several distinguishable characteristics of heavy-duty diesels compared to the remainder of the on-road fleet. Heavy-duty diesel vehicles represent about one percent of the total on-road registered—I emphasize that, registered—vehicle population in California, numbering about 200,000 of our 16 million registered vehicles. However, these same heavy-duty vehicles travel about four times the miles per vehicle than other motor vehicles. And this higher rate of travel, coupled with much higher levels of NO_x and particulate emitted per vehicle cause heavy-duty diesels to be responsible for a disproportionate share of our air pollution. About 30 percent of our motor vehicle NO_x and 75 percent of particulate are emitted by the heavy-duty diesel vehicles. These emissions, as you've already heard, contribute to respiratory disease and in some cases, cancer, with even greater suspicions in that area. They adversely affect visibility; they add to our world-famous ozone, or

smog problem in California; they contribute to acid precipitation and, of course, they contribute to the soiling problem that was referenced.

In my Exhibit 1, which is the next to last page of my testimony, you see that we currently project an overall 50 percent increase in heavy-duty diesel travel by the year 2000. But despite this tremendous increase, we show there will be a 25 percent decrease in particulate emissions inventory because of the programs that we currently have in place, and EPA currently has in place.

Because of the adverse health effects of diesel exhaust, we have adopted stringent NO_x and particulate emissions standards for new diesel trucks and buses. Emission rates of vehicles meeting these standards will be reduced as much as 80 percent by the mid-1990's. To assure emission rates remain low in service, we are developing in-use inspection programs for diesel trucks and buses. We're also evaluating the feasibility of cleaner fuels, such as low sulfur or low-aromatic diesel fuel and methanol, or any other alternative fuel that is brought to the forefront. Implementation of these measures could well reduce particulate emissions from the heavy-duty diesels by an additional 45 percent over and above the reductions shown in my exhibit.

I want to touch on a major problem to us in California. I emphasized the word, registered in California, earlier. Federally certified heavy-duty vehicles operating in California present a problem to us in our efforts to develop strategies to reduce diesel emissions. Up to 50 percent of the daily vehicle miles traveled by the heavier of the heavy-duty diesel trucks is attributable to out-of-state trucks traveling to or through the State of California. This has a profound effect on California's air quality and the control programs proposed for California trucks. The influx of higher-emitting Federal trucks into California reduced the benefits of the more stringent California emission standards. Unfortunately, California standards are not applicable to these out-of-state trucks operating within our State, and this is why California has always, and continues, to encourage Congress and the EPA to adopt the most stringent emission standards and control programs for heavy-duty diesel trucks and buses. And that remains our position.

To achieve even further emission reductions in California, we are evaluating a number of additional control measures. We have adopted strict emissions standards for new heavy-duty trucks and buses, and from 1991 to 1994 we've made our standards the same as the federal standards, frankly to aid in the effort. This, as you've heard, includes more stringent NO_x and particulate standards that may well force the use of traps.

We're currently evaluating even more stringent NO_x emission standards for California. A lower NO_x standard could result in a 20 percent decrease in NO_x emissions for motor vehicles, which will aid us greatly in the ozone reduction needs that we have. We believe a more stringent NO_x standard is feasible, but to be fully effective EPA needs to take parallel action to lower the standard for Federal trucks, which I've already indicated are half our problem.

Revised test procedures and standards for heavier pick-up trucks and lighter heavy-duty trucks are also being proposed in California. The procedures and standards will better represent the vehicles'

actual use, allow in-use compliance testing, and force the use of the best emission-control technology available. This will result in lower emissions from this class of diesels, as well as from the gasoline trucks that would be so effected.

We have completed an initial feasibility study of the inspection of heavy-duty diesel trucks, and have already concluded that it is both feasible and necessary to inspect these vehicles for excessive smoke. We believe that a roadside enforcement program, in lieu of a registration-based inspection and maintenance program could be developed resulting in a dramatic reduction of smoke and particulate. The advantage of a roadside program is that it would be applicable to interstate as well as intrastate trucks and buses. It's likely that this enforcement will cause owners of these vehicles to better maintain their vehicles, which is always the objective of inspection and maintenance efforts. And we plan a pilot program for later this year, which will involve the engine manufacturers, the trucking industry, and our own California Highway Patrol. And it's hoped to begin regular roadside inspection in the year 1990.

The introduction of the catalytic converter, of course, was a major breakthrough in the emission control of gasoline vehicles, and this is something, of course, California pioneered, and of course, it was said it couldn't be done. Similarly, the development of the particulate trap holds great promise in controlling emissions from diesel vehicles. We have sponsored several demonstration programs to evaluate this technology on buses. While the tests were not entirely successful, it does appear that the technical problems encountered, it does appear to us anyway, can be resolved, and that we continue to work with private industry to expedite the development of this technology. And we frankly encourage more research into this area, by any and all involved in influencing research programs.

Our newest demonstration project is with the Ontario Research Foundation. We found it necessary to cross the borders, here. They're going to fit the most promising trap system that we mutually agree on, onto either urban buses or heavy-duty trucks. And a retrofit program such as this may prove to be a very beneficial control strategy because of the immediate benefits you gain. New standards, as you know, are not fully effective for many years after the implementation, particularly until the lower emitting vehicles replace the older higher-emitting vehicles. Urban buses and heavy trucks have an average life span of over ten years. So a retrofit program provides emission benefits from the time that it is implemented, because these older vehicles would be controlled almost immediately.

The most effective short-term approach in controlling emissions from existing on and off-road vehicles may lie in the modification of diesel fuel. Desulfurization and reduction of aromatic content may result in a reduction of up to 34 percent of the particulate emissions and 20 percent of the hydrocarbon emissions. A reduction in sulfur emissions would also occur. We will consider regulations to control diesel fuel later this year. And I want to note for the record, that we have had a control on the sulfur content of diesel fuel in part of California for many years; 0.05 percent by

weight sulfur diesel fuel is the required fuel in the South Coast Air Basin, California.

Concerning clean fuels, we have three major cooperative projects which involve equipping heavy-duty diesel trucks and buses which methanol-fueled engines. These include a three-bus engine retrofit demonstration with the Riverside Transit Authority in the Southern California area. These buses have been in regular service since the month of April of this year, and are receiving excellent response from the public. A sign on the back of the bus points out to the public that there's no black smoke coming from this particular vehicle.

In another methanol bus demonstration, we're cooperating with the Southern California Rapid Transit District, and they're going to buy 30 brand new methanol buses and they hope to have them in regular service by the end of this year. And we're working with them to fund a modern heavy-duty emission test facility at their facilities to help us both carry on our research.

Finally, we have a cooperative program with our own energy commission and engine manufacturers where up to 10 heavy-duty trucks with methanol engines will be placed in urban California service. Each of these is hopefully going to demonstrate long-term feasibility of using alternative fuels under typical in-service conditions.

And another aside here, we are also interested in natural gas. Your questions earlier are very relevant, however, it's really up to engine manufacturers to influence which way you go. We will respond to—we set, as Mr. Wilson said, tail pipe standards and we just want technologies developed to provide those standards. And natural gas is definitely viable. I just think it needs an additional push. We just haven't seen the response there. And the industry probably is better prepared than we are to answer why it isn't happening. I just recently have been exploring natural gas with both the American and Canadian associations involved in it.

One of our major concerns with diesels has been the toxicity of its particulate matter. Diesel particulate is composed mainly of fine carbon. You heard that from Mr. Wilson, less than 10 microns, and they contain carcinogens; they tend to lodge themselves deeply in the human lung and in addition diesel contains sulfates, nitrates, heavy metals and other toxic compounds like benzenes and so-called PAH's or polycyclic aromatic hydrocarbons. We've contracted with an outside contract organization, a research organization, to better quantify this for us and we hope to have the results of this project later this fall.

My second exhibit, the last page, would show you that in addition to controlling emissions from on-road, we're looking at off-road heavy-duty construction equipment for possible control in California. Again, it's a significant portion of our mobile source emissions inventory. These engines are similar to on-road diesels, but at present they have no emission controls or engine modifications to reduce emissions. And we do hope to establish standards for this kind of equipment in the near future. We'll probably seriously look at this in 1989.

So in conclusion, I just want to indicate that we've made every effort to control emissions from heavy-duty trucks, both diesel and

gas. We've established, along with EPA, the most stringent standards in the world, and are evaluating even more technology to establish even lower standards. We plan to consider regulations on fuel quality, as I indicated, and we're looking at procedures and processes relative to the testing of in-use heavy-duty trucks and buses to make sure that they continue in use to meet the standards for the full life.

We have made quite an effort to fund research to promote clean fuels, but as I indicated, it has all tended to go towards methanol for a host of reasons These clean fuels do have this potential to reduce the smoke and the carcinogens associated with diesel particulate and particularly to reduce the reactive nature of the emissions which contribute to ozone. And that's a very high priority with us.

We're vigorously looking at other clean air strategies. Again, I want to underscore, that we have little control over out-of-state trucks that transport goods to our State. And these emissions contribute significantly, and we again have to encourage Congress, the EPA and all federal agencies involved to continue efforts to reduce these emissions. There is a great need for research funds to explore methods of further reducing emissions. I do want to encourage research into clean fuels, alternative fuels, natural gas, methanol. Fuel cells, quite frankly, hold a lot of promise to us, in California, where we seem to find ourselves on the cutting edge once and a while, and we'd like to see more research done there, and electricity, electric vehicles have always held out hope to us, but hasn't developed as fast as we'd like.

Lastly, a comment on industries efforts to meet he 1991 and 1994 standards. I need to caveat this and say that I think we in California are known as being eternally optimistic about the motor vehicle industry's ability to meet technological challenges. There is a long history of concerns and fears from the industry about meeting our requirements, but it's always been followed by success and accomplishment; catalysts, three-way catalysts, light-duty particulate matter traps, 0.4 NO_x, electronics, on-board diagnostics, et cetera. Therefore, we remain confident about this industry's ability to meet both the 1991 and the 1994 standards. In fact, I just want to toss a bouquet in their direction, which doesn't happen too often from us, relative to 1991. As Mr. Wilson has indicated, they've made dramatic progress, particularly in the engine modification area, which wasn't presumed to be the area of emphasis, in meeting the 1991 standards. And we feel, we both feel quite good about the ability to meet the 1994 particulate standards.

I thank you very much, and I appreciate the opportunity.

[The prepared statement of Mr. Boyd follows:]

CONTROLLING EMISSIONS FROM HEAVY-DUTY DIESEL VEHICLES IN CALIFORNIA

James D. Boyd, Executive Officer
California Air Resources Board

House Committee on Science, Space, and Technology
Subcommittee on Transportation, Aviation and Materials

July 13, 1988

Good afternoon Chairman McCurdy and members of the committee. I am pleased to be here today to address you regarding California's program to control emissions from heavy-duty trucks and buses. Although the diesel vehicle population is small in comparison to gasoline vehicles, diesels contribute significantly to California's ambient air quality problems. Emissions of particulate matter and oxides of nitrogen are most readily associated with diesel vehicles, and of the two, particulate matter or smoke is perhaps the most objectionable to the public. This is especially true of heavy-duty diesel vehicles which can emit levels of smoke and soot twenty times that of comparable gasoline vehicles.

Today, I will review the ARB's on-going emission control efforts for heavy-duty diesel trucks and buses. I will discuss the standards for these vehicles, the use of cleaner fuels, the inspection of in-use vehicles, diesel toxic emissions, and various research projects funded by the ARB to encourage the use of new technology.

There are several distinguishable characteristics of heavy-duty diesels compared to the remainder of the on-road motor vehicle fleet. Heavy-duty diesel vehicles represent about one percent of the total on-road vehicle population in California, numbering about 200,000 out of about 16,000,000 registered vehicles. However, heavy-duty diesels travel about four times the miles per vehicle than other motor vehicles. The higher rate of travel coupled with much higher levels of NOx and particulate

emitted per vehicle cause heavy-duty diesels to be responsible for a disproportionate share of air pollution. About thirty percent of the NOx and seventy-five percent of the particulate are emitted by heavy-duty diesel vehicles. These emissions contribute to respiratory diseases and cancer. They also adversely affect visibility, and add to ozone, acid precipitation and soiling problems.

(Please see Exhibit One) We currently project an overall fifty percent increase in heavy-duty diesel travel by the year 2000. Despite this tremendous increase, there will be a twenty-five percent decrease in the particulate emissions inventory because of the programs we currently have in place.

The Board has recognized the adverse health effects of diesel exhaust and is aggressively pursuing programs to reduce these emissions. The Board has adopted stringent NOx and particulate emission standards for new diesel trucks and buses. Emission rates of vehicles meeting these standards will be reduced as much as eighty percent by the mid-1990's. To assure emission rates remain low in service, we are developing in-use inspection programs for diesel trucks and buses. We are also evaluating the feasibility of cleaner fuels, such as low-aromatic diesel fuel and methanol. When these measures are implemented, particulate emissions from the heavy-duty diesels will be reduced by an additional forty-five percent over and above the reductions shown in Exhibit One.

Federal vehicles operating in California present a major problem in developing strategies to reduce diesel emissions. A recent study showed that up to fifty percent of the daily travel by the heavier heavy-duty-diesel trucks is attributable to out-of-state trucks traveling through California. This has a profound effect on California's air quality and the control programs proposed for California trucks. The influx of higher-emitting federal trucks into California reduces the benefit of

the more stringent California emission standards. On an economic note, the California truck and bus industries have had to endure fewer available models, and sometimes fuel penalties, for the privilege of doing business in California. Unfortunately, the California standards are not applicable to the out-of-state vehicles operating within the state. This is why California has always encouraged Congress and the EPA to adopt the most stringent emission standards and control programs for heavy-duty diesel trucks and buses.

To achieve further emission reductions in California, we are evaluating a number of additional control measures which I will describe briefly. The ARB has adopted stringent emission standards for new heavy-duty diesel trucks and buses, and from 1991 to 1994, California's emission standards will be the same as the federal standards. These include a more stringent NOx standard, and particulate standards which will force the use of particulate traps. Aligning with the federal heavy-duty diesel standards should improve the model availability in the state and eliminate any fuel economy disparity between federal and California trucks.

We are currently evaluating even more stringent NOx emissions standards for California. A lower NOx standard could result in a 20 percent decrease in NOx emissions from motor vehicles which will aid in ozone reduction. We believe a more stringent NOx standard is feasible, but to be fully effective EPA needs to take parallel action to lower the standard for federal trucks, which are one-half of California's diesel pollution problem.

Revised test procedures and standards for heavier pick-up trucks and lighter heavy-duty trucks are also being proposed. The procedures and standards will better represent the vehicles' actual use, allow in-use compliance testing, and force the use of the best emission-control technology. This will result in lower

emissions from this class of diesels, as well as from gasoline trucks.

The ARB has completed an initial feasibility study regarding the inspection of heavy-duty diesel trucks and has concluded that it is both feasible and necessary to inspect these vehicles for excessive smoke. We believe that a roadside enforcement program in lieu of a registration-based inspection and maintenance program could be developed resulting in a dramatic reduction of smoke and particulate. The advantage of a roadside program is that it would be applicable to interstate as well as intrastate trucks and buses. It is also likely that roadside enforcement will cause vehicle owners to better maintain their vehicles, which is the objective of any inspection program. A pilot program is planned for late this year which will involve engine manufacturers, the trucking industry and the California Highway Patrol. We intend to begin regular roadside inspections in 1990.

The introduction of the catalytic converter was a breakthrough in the emission control of gasoline vehicles. Similarly, the development of the particulate trap holds great promise in controlling emissions from diesels. The ARB has sponsored several demonstration programs to evaluate this technology on buses. While the tests were not entirely successful, it appears that the technical problems encountered can be resolved. The ARB continues to work with private industry to expedite the development of this technology.

The newest demonstration project is with the Ontario Research Foundation. This contractor will fit the most promising trap system on two urban buses or heavy-duty trucks. A retrofit program such as this may prove to be a very beneficial control strategy because of the immediate benefits. New standards are not fully effective for several years after their implementation until lower emitting vehicles replace the older higher-emitting

vehicles. Urban buses and heavy-duty trucks have an average life span of over ten years. A retrofit program provides emission benefits from the time it is implemented because the older on-road vehicles are controlled immediately.

The most effective short-term approach in controlling particulate emissions from existing on- and off-road diesel vehicles may lie in the modification of diesel fuel. Desulfurization and reduction of aromatic content may result in a reduction of up to 34 percent of the particulate emissions and 20 percent of the hydrocarbon emissions. A reduction in sulfur emissions will also occur. The ARB will consider regulations to control diesel fuel later this year.

Concerning clean fuels, we have three major cooperative projects which involve equipping heavy-duty-diesel trucks and buses with methanol-fueled engines. These projects include a three-bus demonstration with the Riverside Transit Agency. The buses have been in regular service since April and are receiving excellent response from the public. A sign on the buses points out to the public that no black smoke is emitted from the bus.

In another methanol bus demonstration, the ARB is cooperating with the Southern California Rapid Transit District. Thirty brand new methanol buses should be in regular service later this year. A modern heavy-duty emissions test facility is also being constructed at the Rapid Transit District. And finally, there is a cooperative test program with the California Energy Commission and engine manufacturers where up to ten heavy-duty trucks with methanol engines will be placed in urban service. Each of the bus and truck projects will demonstrate the long-term feasibility of using alternate fuels under typical in-service conditions.

One of the major concerns with diesel emissions has been the toxicity of its particulate matter. Diesel particulate is

composed mainly of fine carbon particles that are less than ten microns in diameter. The particles contain carcinogenic compounds and tend to lodge in the human lung when inhaled. In addition to the carbon particulate, diesel exhaust contains sulfates, nitrates, heavy metals, and toxic compounds such as benzene and polycyclic aromatic hydrocarbons. The ARB has contracted with the Southwest Research Institute to better quantify the hazardous components of diesel exhaust. The project should be completed by this fall.

(Please see Exhibit Two) In addition to controlling the emissions from on-road vehicles, the ARB is evaluating off-road heavy-duty construction equipment for possible control. Off-road equipment represents a significant portion of the California mobile source emissions inventory. The engines in these vehicles are similar to the on-road diesel trucks, but they have no emission controls or modifications to reduce emissions. The ARB hopes to establish standards for this equipment in the near future.

In conclusion, the ARB has made every effort to control the emissions from heavy-duty diesel trucks and buses. We have established the most stringent standards for heavy-duty vehicles in the world and are evaluating the available technology to establish even lower emission standards in the future. We plan to consider regulations to improve the quality of diesel fuel to further reduce emissions from both the new and in-use diesel vehicles. The ARB is also in the process of establishing procedures to test in-use heavy-duty trucks and buses to make sure they continue to meet the emission standards for their full life.

We have made a significant effort to fund research projects to promote clean fuels such as methanol. These have the potential to reduce black smoke and the carcinogens associated

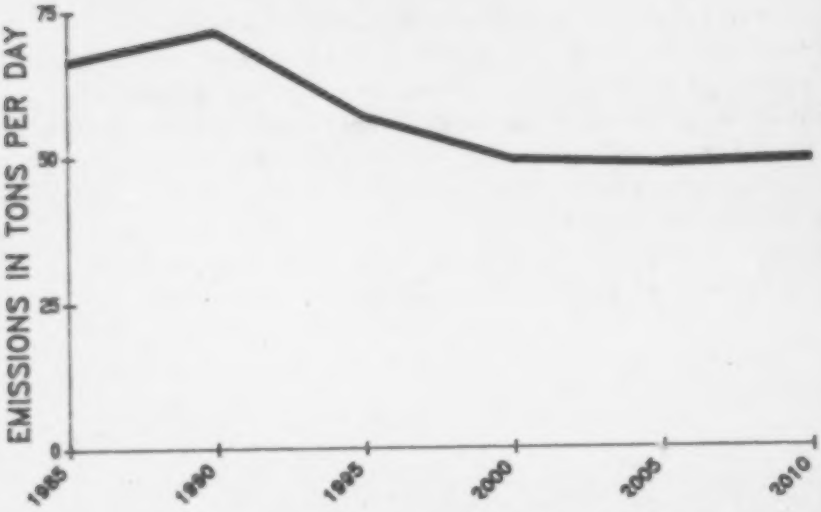
with diesel particulate and to reduce the reactive nature of the emissions which contributes to ozone formation.

California is vigorously pursuing cleaner air. Unfortunately, we have little control over out-of-state trucks that transport goods throughout our state. The emission contribution of these vehicles is significant and may become even more significant as California vehicles become cleaner. California needs the EPA and the federal government to continue their efforts to reduce heavy-duty diesel truck and bus emissions. There is also a great need for research funds to explore methods of further reducing diesel emissions.

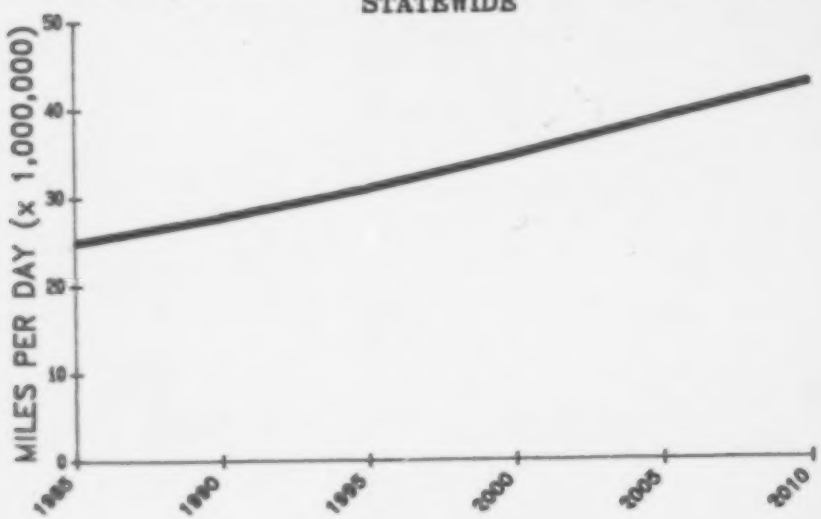
Again, I would like to thank you for the opportunity to testify today.

EXHIBIT ONE

HEAVY-DUTY-DIESEL EXHAUST PARTICULATE EMISSIONS
STATEWIDE



HEAVY-DUTY-DIESEL DAILY VEHICLE MILES TRAVELED
STATEWIDE



"Other Mobile" NOx Emissions by Source Category
Year 2000 South Coast Air Basin

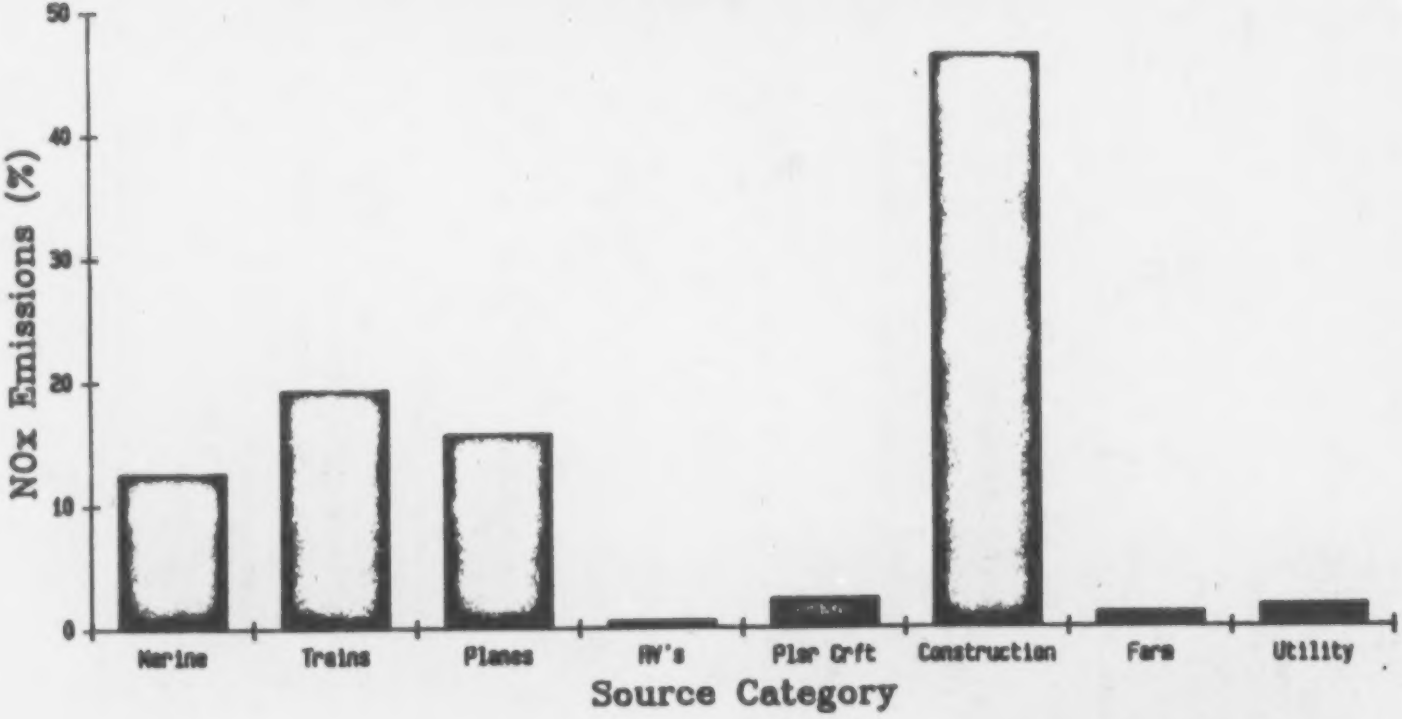


EXHIBIT TWO

Mr. McCURDY. Thank you, Mr. Boyd.

Mr. Bailey and Mr. Matthews, we need to take a 10-minute break here for a recorded vote. We'll return shortly afterwards, and hear your statements, and then ask some questions, and then one last witness after that.

[Recess.]

Mr. McCURDY. The subcommittee will be back in order.

I apologize for the delay. We had a vote on the floor on the bank closings bill. They're taking up the trade bill now, so we'll probably have a couple hours to finish up the hearing.

Mr. Bailey, appreciate you appearing today. Your statement is admitted into the record and you may proceed.

STATEMENT OF MR. LEROY R. BAILEY, JR., ASSISTANT GENERAL MANAGER FOR BUS SERVICE, WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Mr. BAILEY. Thank you, Mr. Chairman. It's indeed a pleasure for me to have the opportunity to testify before your committee on behalf of WMATA, to explain our emissions control program for buses.

The Washington Metropolitan Area Transit Authority was created by Act of Congress in 1967, by Interstate Compact agreed to by Maryland, Virginia and the District of Columbia. The Authority is one of the Nation's largest transit property, employing more than 8,500 people to operate and maintain a regional public rail and bus system.

The rail system has been in operation for over 12 years, and is currently 70 miles in length with 64 stations in revenue service. And the bus system now in its 15th year is the fifth largest in the Nation. Metro provides almost a million passenger trips daily on bus and rail. There are 12 different types of buses in Metro's diverse fleet of 1,576 vehicles. Our fleet is stored and maintained in nine bus garages throughout the region and serviced by 834 bus maintenance technicians.

The fleet is titled and licensed in the District of Columbia and we are required by law to have semi-annual inspections performed on each vehicle. We comply with all requirements cited in the District of Columbia Motor Vehicle Inspection Manual.

The Authority has historically supported a quality clean air program. We recognize that beginning in 1991, all new buses purchased will have to meet more stringent Federal air quality emission standards. We have committed both staff and funds towards the goal of improving air quality and being a good neighbor in the community.

I would like to summarize our emissions control program. We have converted our entire fleet from Diesel Fuel Blend Number 2 to Diesel Fuel Number 1, a more efficient, cleaner burning and more highly refined fuel.

The Authority has a long standing restriction that buses are not allowed to idle in residential areas and only idle for three minutes in non-residential areas.

All bus service mechanics are required to complete a factory sanctioned training program. Additionally, all new bus procure-

ments contain a requirement that the manufacturer is to furnish maintenance instructors and a state-of-the-art maintenance curriculum.

All new WMATA bus purchases require the coach manufacturer to provide electronically controlled engines. The purpose of electronics is to optimize performance and economy while controlling exhaust emissions.

In addition to the state-of-the-art electronically controlled engine, WMATA has also specified transmissions governed by a microprocessor-controlled electronic unit. This unit provides optimum shifting in line with engine calibration.

In keeping with our quality assurance program, a separate quality assurance branch monitors and audits all bus maintenance to assure that stringent engine and transmission maintenance has been performed. As our buses are being built, WMATA quality assurance inspectors are dispatched to the manufacturing facility as on-site, full-term resident inspectors during the complete manufacturing/assembly cycle. WMATA inspectors monitor, check and verify each item or phase of the manufacturing/assembly process, including engines before acceptance.

The Authority has, and continues, to participate in research programs with various industry groups, including the Transportation Research Board, and the American Public Transit Association in the critical areas of emerging engine technologies and alternative fuels. We also regularly share information with engine suppliers and bus manufacturers.

Through this industry participation we have been generally monitoring development of diesel technology. Based on our understanding, it does not appear that any diesel engines that may be commercially available in the next few years will be able to meet the EPA emissions standards that become effective in 1991. While alternative fuels such a methanol, propane, or alcohol may provide a means to meet the 1991 standards, we are concerned about the implications of this, as yet, unproven technology.

Some of our major concerns are safety. It has been long one of our highest priorities. We are extremely concerned that there is insufficient time for the industry to properly evaluate and test the crashworthiness and fire protection of vehicles using alternate fuels.

Many alternative fuels are more volatile and difficult to handle as delivery, storage, fueling and maintenance functions are performed. In addition to adding special storage and fueling facilities, our bus technicians would have to be retrained to handle alternative fuels.

Purchasing buses that use alternative fuels would require us to incur substantial capital costs to construct an entirely new infrastructure system including storage tanks, pumps, fuel fittings, lines, service lanes, and additional fire protection and building ventilation systems. In addition, our bus garages, for the most part, are located in densely populated, urban areas where the additional land necessary to support this additional requirement is not available.

It is not clear that an adequate supply of some of these alternative fuels exists to provide a constant flow of fuel for not only

Washington Metro's needs, but also the needs of transit properties across the country.

Vehicle performance and changes in operating characteristics, such as the weight of the vehicle, acceleration and potential route restrictions, with alternative fuels have not been adequately researched and could substantially effect our ability to provide reliable service and hold down operating costs.

It is unclear what the long-term effects of alternative fuels are on the environment. Specifically, more research is called for on the emissions of alternative fuels.

In conclusion, we have a longstanding vehicle emissions control program aimed at achieving better air quality throughout the region. We constantly strive to improve our service, and to do everything we can to be a good neighbor in the communities we serve.

We stand committed to working with the transit industry, engine manufacturers and the Federal Government in exploring the long-term implications of new engine and emissions technologies and alternative fuels. We would encourage additional research on some of these yet unproven technologies and fuels. Utilizing the results of the proposed research and coordinating closely with the industry is important to the goal of improving the Nation's air quality in a cost effective manner.

Thank you.

[The prepared statement of Mr. Bailey follows:]

STATEMENT

OF

LEROY R. BAILEY, JR.

ASSISTANT GENERAL MANAGER FOR BUS SERVICE

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

JULY 13, 1988

Good afternoon Mr. Chairman, I am LeRoy R. Bailey, Jr., Assistant General Manager for Bus Service of the Washington Metropolitan Area Transit Authority. I am pleased to be here this afternoon to testify on behalf of WMATA to explain our emissions control program for buses.

OVERVIEW OF THE TRANSIT AUTHORITY

The Washington Metropolitan Area Transit Authority (Authority) was created by the Congress, effective February 20, 1967, by Interstate Compact agreed to by Maryland, Virginia and the District of Columbia. The Authority's mission is to plan, construct, finance and operate a public transit system serving the Washington Metropolitan Area Transit Zone, including the District of Columbia and seven local jurisdictions in Virginia and Maryland.

The Authority is one of the nation's largest transit properties, employing more than 8,500 people to operate and maintain a regional public bus and rail system. The combined Metrobus and Metrorail system serves as a critical component of the region's transportation network, allowing residents of the region, as well as visitors from across the country and around the world to travel on a safe, reliable, clean, modern system.

The rail system has been in operation for over 12 years, and is currently 70 miles long with 64 stations in revenue service. The bus system is in its 15th year of service and consists of 1,576 vehicles

in the fleet. Metro provides almost a million passenger trips daily on bus and rail. There are 12 different types of buses in Metro's diverse fleet. Our fleet is stored and maintained in 9 bus garages throughout the region and serviced by 834 bus maintenance technicians.

The fleet is titled and licensed in the District of Columbia and we are required by law to have semi-annual inspections performed on each vehicle. We comply with all requirements cited in the District of Columbia Motor Vehicle Inspection Manual including emissions which are checked on the Ringlemann Smoke Chart, used throughout the industry.

EFFORTS TO REDUCE VEHICLE EMISSIONS

The Authority has historically supported a quality clean air program through policies, procedures and maintenance initiatives. We recognize that beginning in 1991, all new buses purchased will have to meet more stringent Federal air quality emission standards. We have committed both staff and funds towards the goal of improving air quality and being a good neighbor in the community. These initiatives have been accomplished through the following:

o OPERATIONS, MAINTENANCE, PROCUREMENT AND RESEARCH PROGRAMS

- Systemwide Conversion from Diesel Fuel Blend No. 2 to Diesel Fuel No. 1: Diesel fuel No. 1 is a more efficient, cleaner burning, highly refined fuel. Beginning in 1983, bus vehicles were switched to Diesel No. 1, with fleetwide conversion occurring in 1987;

- Reduced Idling of Buses: The Authority has a long standing restriction that buses are not allowed to idle in residential areas and can only idle for three minutes in non-residential areas;

- Improved Tune-up and Maintenance Techniques Through Added Training Initiatives: WMATA supports a highly qualified technical training staff that schedules all Bus Service mechanics through a factory sanctioned training program. Additionally, all new bus procurements contain comprehensive requirements stipulating that the manufacturer is to furnish maintenance instructors and a state-of-the-art maintenance curriculum;

- Procurement of State-of-the-Art Diagnostic Equipment and Tools: WMATA, through its capital program, has continued to update the necessary support equipment to maintain its bus fleet. Tune-up verification equipment currently under consideration for purchase includes opacity meters, infrared detectors and smoke measuring devices;

- Specifying Electronically Controlled Engines on All New Bus Procurements: All new WMATA bus procurements specifically require the coach manufacturer to provide electronically controlled engines. The purpose of electronics is to manage engine operation under continually varying service conditions optimizing performance and economy while controlling exhaust emissions. The sophistication of the control unit includes a self-diagnosing feature, as well as offering each operator the flexibility to program differences in terrain and traffic conditions;

- Specifying Electronically Controlled Transmissions: In addition to the state-of-the-art electronically controlled engine, WMATA also specifies transmissions governed by a microprocessor-controlled electronic unit. This unit provides optimum shifting qualities in line with engine calibration. This unit also provides a self diagnostic capability, as well as specific operation programming for differences in terrain and traffic conditions;

- Monitoring Industry Research Projects: Through our participation with industry organizations, the Authority is constantly reviewing various industry testing programs. The test projects include alternate fuel testing of methanol, propane and alcohol.

o QUALITY CONTROL AND ASSURANCE INITIATIVES

Although all bus maintenance garages in WMATA have established high quality control standards consistent with industry practices, a separate Quality Assurance Branch monitors and audits all bus maintenance to assure that stringent engine and transmission maintenance has been performed. This assurance is verified by:

- Using water manometers that measure engine air induction levels of proper amounts to ensure exact fuel/air ratios necessary for clean burning engines;

- Checking air restriction indicators (installed on all bus engines) to identify clogged air filters;

- Checking engine stall speeds, idle speeds and maximum engine speeds as indicators of engine performance and condition;

- In addition, technical questions and/or problems from the bus garages are resolved by the Quality Assurance Branch. Technical manuals as well as communicating directly with the manufacturer or vendor enable us to maintain current information on maintenance procedures.

o ON-SITE QUALITY ASSURANCE INSPECTORS

As our buses are being built, WMATA quality assurance inspectors are dispatched to the manufacturing facility as on-site, full-term resident inspectors during the complete manufacturing/assembly cycle. WMATA inspectors monitor, check and verify each item or phase of the manufacturing/assembly process, including engines. Changes or deviations from our specifications are not tolerated and problems are resolved prior to vehicle acceptance.

ECONOMIC IMPACT OF NEW TECHNOLOGIES AND ALTERNATIVE FUELS

The Authority has participated in the research programs of various industry groups in the critical area of emerging engine technologies and alternative fuels. We have been closely involved

with the American Public Transit Association's efforts to promote a greater understanding in this area, as well as sharing information regularly with engine suppliers and bus manufacturers. In particular, we are active on APTA's Bus Equipment and Technology Subcommittee which includes bus and component manufacturer representatives and transit operators.

Through this industry participation, we have been generally monitoring development of diesel engine technology. Based on our understanding, it does not appear that any diesel engines that may be commercially available in the next few years will be able to meet the EPA emissions standards that become effective in 1991. While alternative fuels such as methanol, propane or alcohol may provide a means to meet the 1991 standards, we are concerned about the implications of this, as yet, unproven technology. Some of our major concerns follow:

- Safety has long been the highest priority of the Authority. We are extremely concerned that there is insufficient time for the industry to properly evaluate and test the crashworthiness and fire protection of vehicles using alternate fuels;

- Many alternative fuels are more dangerous (volatile) and difficult to handle as delivery, storage, fueling and maintenance functions are performed. In addition to adding special storage and fueling facilities, our bus technicians would have to be retrained to handle alternative fuels;

- Purchasing buses that use alternative fuels would require us to incur substantial capital costs to construct an

entirely new infrastructure system including storage tanks, pumps, fuel fittings and lines, service lanes, and additional fire protection and building ventilation systems. It is difficult for us to estimate the costs associated with infrastructure improvements, operating costs, or new bus purchases, since cost information on these items is not yet available to the transit industry.

- Maintaining a dual fleet using both diesel and alternative fuel buses could also severely impair our ongoing efforts to improve cost control and operating efficiencies. This is an especially important consideration during this time of fiscal constraint. A dual fleet essentially means a dual system of procurement, storage, maintenance and training. In addition, our bus garages, for the most part, are located in densely populated, urban areas where the additional land necessary to support this additional requirement is not available;

- It is not clear that an adequate supply of some of these alternative fuels exists to provide a constant flow of fuel for not only Washington Metro's needs, but also the needs of transit properties across the country;

- Vehicle performance and changes in operating characteristics (such as, weight of the vehicle, acceleration and potential route restrictions) with alternative fuels have not been adequately researched and could substantially effect our ability to provide reliable service and hold down operating costs;

- It is unclear what the long term effects of alternative fuels are on the environment. Specifically, more research is called for on the emissions of alternative fuels.

CONCLUSION

In conclusion, the Washington Metropolitan Area Transit Authority has a longstanding vehicle emissions control program aimed at achieving better air quality throughout the region. We constantly strive to improve our service and to do everything we can to be a good neighbor in the communities we serve. Our air quality program is part of that effort.

We stand committed to working with the transit industry, engine manufacturers and the Federal Government in exploring the long term implications of new engine and emissions technologies and alternative fuels. We would encourage additional research on some of these yet unproven technologies and fuels. Utilizing the results of the proposed research and coordinating closely with the industry is important to the goal of improving this nations air quality in a cost effective manner.

Mr. MCCURDY. Thank you, Mr. Bailey.
Mr. Matthews.

STATEMENT OF MR. CRAIG G. MATTHEWS, GROUP SENIOR VICE PRESIDENT AND CHIEF FINANCIAL OFFICER, THE BROOKLYN UNION GAS COMPANY, BROOKLYN, NEW YORK, ON BEHALF OF THE AMERICAN GAS ASSOCIATION

Mr. MATTHEWS. Mr. Chairman, I complement the subcommittee on its close examination of technical issues from the emissions of heavy-duty engines involved with alternative fuels.

My written testimony is a lot more detailed than my oral comments will be. I'm speaking today on behalf of the American Gas Association. It represents over 250 utilities in the United States. It's a trade association serving 166 million customers and 81 percent of the total gas sales in the United States.

And also as a representative of Brooklyn Union Gas Company, which is one of those trade association members; 1.1 million customers in New York City; one billion cubic feet of sales, $800 million in assets, but only two methane buses.

Natural gas vehicles are relatively new to the U.S. markets. I think that's primarily because the focus of utilities has been on selling to the traditional markets in heating, water heating, cooking, and in recent periods, co-generation. At the same time, producers of oil and gas in the United States have traditionally been liquid oriented in a large percentage of their market, and certainly a large percentage of their assets focused on transportation fuel, some gasoline, primarily diesel.

Transportation provides 63 percent of all oil in the United States and has a significant interest in keeping that system alive. There have been some recent changes, however, in recent years focusing attention on alternate fuel.

First, oil reserves have been depleting, domestic production of oil has clearly been declining. No one argues with that. That's factual. As a result, oil imports have been rising. At the same time, natural gas as a resource, has found to be abundant. There are 60 years of proven reserves, easily, out there. A recent Department of Energy study confirmed the abundance of these resources, and in fact, said it could last up to 200 years. And more details of that is in my written testimony.

At the same time producing states eager to sell gas, because of the gas bubble currently existing, has resulted in certain coalitions being formed. The Natural Gas and Clean Air Conference by the Texas General Land Office, the Sierra Club, and the American Gas Association is one example of that back in April.

Finally, and probably most importantly, there has been a desperate need for cleaner air. EPA has targeted almost a hundred areas in violation of the Clean Air Act, the pollution issue is intensifying, and there's been an increasing shift from stacks to tailpipes. From a legislative perspective two years ago, natural gas was not even mentioned in any legislation on clean air. Now, every alternative fuel bill includes natural gas.

We are also in the process of building environmental coalition, that is, the industry is. We're working with World Resources Insti-

tute, who has put together a consortium of environmentalists; the National Clean Air Coalition, Lines to Save Energy, Institute for Renewable Management, the Sierra Club, that are proponents of natural gas and want to use it to help solve the ozone and greenhouse problem, recognizing its assets from an air pollution perspective.

Coming from a personal perspective, and as a resident of the New York City area, each of us breathes about 22,000 breaths of air daily. A primary source of pollution comes from vehicles. Vehicles contribute 69 percent of carbon monoxide, 35 percent of hydrocarbons, and 44 percent of NO_x. The worst urban source of this transportation fuel is clearly diesel, and I don't think there's any argument about that. And the most hazardous use of diesel is in buses. Their stop and go; their proximity to pedestrians and because of their high concentration; 6,000 buses alone in the City of New York, 24,000 in the New York City Metropolitan Area.

EPA, the generalization agrees, I think, that diesel buses are the first target in which must be converted so that we can eliminate this heavy pollution. However, EPA has also had, historically, a clear preference toward methanol. The preference, I think, was chosen or came about in the 1970's when they felt there was an apparent shortage of natural gas, which obviously has not proven to be true given the glut we have today. They had hoped coal might be the source of that fuel, and they've concentrated and focused on the interests of liquid to liquid. Charles Gray and Jeff Olson, who head the EPA Emissions Laboratory in Ann Arbor wrote a book entitled, *Moving America to Methanol*, in 1985. I think that suggests where their interest historically has been.

In fairness, they are now showing some interest in natural gas vehicles, since we've brought our project to their attention and got them to test our engine. EPA's interest in methanol was also focused and concentrated on a clean air problem where General Motors was found to be in violation of the Clean Air Act in the late 1970's. As part of an out-of-court settlement, a penalty was assessed against GM wherein they would produce 26 methanol buses, the first six of which were delivered to New York City several weeks ago.

Brooklyn Union's position is that methanol has some distinct disadvantages that have not been highlighted today. It is an extremely corrosive fuel. It has an invisible flame, and despite—I will verify my records, but all of my technical experts tell me despite the testimony of Mr. Wilson that there is more carbon monoxide produced from methanol, even methanol produced from natural gas, than natural gas direct usage in the vehicle, and obviously you don't have the conversion loss or the efficiency loss in the conversion. Obviously, methanol, if you look at any of the energy forecasts, the primary source would be imported. A fact that certainly this committee and any other should consider in terms of energy security and balance of payments.

Natural gas, we believe, has clear major advantages; Domestic resource and ample supply. It is cleaner burning. It has no aldehydes, and it's as available as the main is in the street, the 1,100,000 miles of mains in the streets this country.

Why did Brooklyn Union undertake the risk of building two buses? We're certainly not technical experts in the development of heavy-duty truck or bus engines. However, we felt we wanted a fair comparison to methanol to some of these proposed projects like EPA's agreement with General Motors on the six buses for New York City. We felt the public should have an opportunity for free choice in these major cities. New York City has the highest density bus traffic of any city in the United States, and of any city in the entire North American continent, with the exception of Mexico City.

We have had successful experience with smaller natural gas engines. Italy has had 200,000 natural gas vehicles since the 1940's. New Zealand, over 100,000 natural gas vehicles. In Canada alone, the government has had a major shift to subsidizing industry to increase the number of natural gas vehicles and they have almost 20,000 right now, and have subsidized that RD&D funding for the number of stations and the conversions to those vehicles.

I think this addresses Mr. Bailey's concerns over the safety issue. There have been no problems in the past 40 years that these natural gas vehicles have been in existence to preclude their conversion or their production. And in addition, or by comparison, there are only an estimated 1,000 methanol vehicles that have ever been produced and are running in the United States or worldwide currently, almost all of which are in California right now. Compare that against the 300,000 natural gas vehicles that are operating.

We undertook construction of these two buses at our own cost. The engine comes from Canada. It's a Fiba-Canning engine. The bus is from Bus Industries of America in Oriskany, New York. These were the only manufacturers that we found had a positive attitude toward compressed natural gas, and were willing to make a conversion in a short period of time so that we could have a product that was put on the market simultaneously with the methanol buses.

We announced our plans for this project to EPA in Ann Arbor, who quite frankly, very severely doubted the claims of emissions that we felt were possible. They suggested some emissions tests, which we had performed at Ontario Research Foundation, one of their recommended facilities, and the tests were so positive the EPA agreed to test them in their own laboratory. It was the first test that they had ever undertaken of a natural gas engine of this size. Those emissions results were as follows: in particulates, this particular bus had a 0.02 measure compared to the EPA 1991 standard of 0.1, which is for urban buses; NO_x was 1.4, relative to the EPA 1991 standard of 5.0; carbon monoxide was 10.6, versus the standard of 15.5. That was higher than we anticipated, and we think this is the first engine that was put out there, and with some improved research this can clearly be brought down. Hydrocarbons were also relatively high, although they clearly met the 1991 standard. But I would point out that those hydrocarbons of 1.2 versus the standard of 1.3, 85 percent of them are non-reactive. And I'm told by my experts that that's a significant difference, non-reactive versus reactive.

It's doubtful in my personal mind and from the testimony that I've heard today, that diesels will be able to achieve those stand-

ards by 1991, or certainly by 1994. Our engine, again, is the first of its kind, and improvements will likely come as we can get manufacturers, and if we can get manufacturers, to introduce any research or the Government, or gas research institutes to do so.

From a demand perspective, the total potential for natural gas vehicles—I've stated some numbers that American Gas Association has forecasted. The growth, if it's vigorous could be as many as 80,000 vehicles by the year 2000, that are converted, and perhaps as many as another 170,000 vehicles that are manufactured directly. Fortunately, only a small portion of them would be diesels. Even though those numbers of vehicles may sound relatively large, the impact on gas demand in the United States is very small. From those numbers, and the two scenarios that AGA did, they would only represent from .7 to two percent of total gas demand in the United States.

Our bus program in New York City, although the buses were down here in Washington several weeks ago, were officially dedicated by Mayor Koch on July 7th. They are now being instrumented before going into revenue service by the Command Bus Company, the regular bus company that focuses in Brooklyn and Queens, and the New York City Area, and they will be evaluated for three years. We will have some results, obviously, before that period, but it will be a full three-year test.

Other demonstration programs that we're working on besides the conversion of 200 of our own vehicles within the company fleet, the Department of Sanitation in New York City is extremely interested in methane for application in not only their sedans and light trucks, which we're going to convert a sample in the very near future, but more importantly for their packers, because these trucks last. The primary core basic garbage truck lasts for a lot longer than the engine. The engine is replaced. So they have a great interest in this, as does the fire department, and we will be converting a number of their light trucks with their focus on heavier engines for their larger trucks in the future.

We're also working with another Canadian company, manufacturer, who has interest in methane, called the Bionic Taxi, a uniquely designed taxi that instead of metal on the outside, it has rubber on the outside so it can bump into anything and not be scratched. And it's fueled as a dedicated vehicle by natural gas. John Deere Company has stepped out as a manufacturer and is producing a light-duty truck chassis for a variety of applications where there will be a dedicated bus engine and Brooklyn Union is promised the first truck off that assembly line.

There is also interest internationally. Mercedes-Benz in Brazil has recognized the potential for methane engines and are producing a standard engine for their light truck assemblies, and we're speaking with them now, perhaps about important an engine if there is not enough interest by U.S. manufacturers.

In conclusion, we need some Congressional help. We clearly need to create a level playing field with all parties against all alternative fuels so that methane gets a fair shake. Give natural gas an equal chance to be tested. It has the most experience of any of the alternative fuels in smaller applications throughout the world. Consider the source of the fuel. It is domestic rather than imported.

Implement the policy that was described under the Alternative Motor Fuels Act of 1987, particularly those sections that support natural gas with which the environmentalists have no problem; provide funding to the commercial sector to participate in more demonstration programs; provide guidance to cities, states, and Federal agencies to help them develop their own demonstration program; provide economic incentives to offset the initial out-of-pocket costs that will be required for conversion of vehicles until we can get more manufacturers to make dedicated vehicles right off the assembly line.

We need to have the Government stimulate and be partners in research by engine manufacturers, particularly with regard to low emissions of nitrogen oxides even in natural gas engines and catalytic conversion methodology, or natural gas application. We have certain interests from Cummins, from Caterpillar Engine—I mentioned Mercedes-Benz, unfortunately I didn't hear I didn't hear anything from Detroit Diesel.

Finally, perhaps the Federal Government should consider ordering a set percentage of all buses and heavy trucks that they use in their contracts, such as Congressman Fazio from California suggested for the non-attainment areas, or demonstration programs as proposed by Senator D'Amato, where UMTA grants could be given for up to 50 buses tested in the New York City area.

Gentlemen, I thank you for your time.

[The prepared statement of Mr. Matthews follows:]

STATEMENT OF
CRAIG G. MATTHEWS
GROUP SENIOR VICE PRESIDENT AND CHIEF FINANCIAL OFFICER
THE BROOKLYN UNION GAS COMPANY
ON BEHALF OF THE
AMERICAN GAS ASSOCIATION
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
ON NATURAL GAS USE IN VEHICULAR APPLICATIONS
JULY 13, 1988

Introduction

I am Craig Matthews. I am appearing today on behalf of the American Gas Association (A.G.A.) so that a broad spectrum of the natural gas industry's views can be provided. Moreover, the experiences of the Brooklyn Union Gas Company are informative with respect to demonstration projects and vehicle emissions and will be included in this statement.

The A.G.A. is a national trade association comprising some 250 natural gas distribution and transmission companies serving more than 166 million gas consumers. Collectively, these companies account for about 81 percent of the nation's total gas utility sales.

Brooklyn Union is one of those natural gas distribution companies, supplying gas to 1.1 million customers in Brooklyn, Staten Island, and most of Queens, all boroughs of New York City.

Motor vehicles are the source of 69% of the nation's carbon monoxide (totalling 70 million tons annually), 35% of hydrocarbon emissions, and 44% of nitrogen oxides emissions.

A.G.A. and Brooklyn Union believe that vehicular use of natural gas for transportation purposes can help to achieve significant reductions in vehicle emissions of these pollutants. These reduced emissions would contribute to improved air quality in various parts of the country, particularly heavily congested urban areas. While our area of expertise is not in the technological development of heavy duty truck and bus engines, we can offer valuable observations on concerns related to the increased use of natural gas in vehicles that use such engines. These relevant concerns are addressed below.

Air Quality Benefits of Natural Gas Vehicles (NGVs)

In the interests of demonstrating the benefits of operating buses on compressed natural gas, Brooklyn Union paid for the construction of 2 such buses which were donated to the City of New York for $1 per year.

Recently, EPA conducted its own testing of the Brooklyn Union buses at its motor vehicle facility at Ann Arbor, Michigan. The results of these tests show that, not only did the engine used in a natural gas bus more than meet today's emission standards, it surpassed the EPA bus engine standards for 1991. No existing diesel-powered bus today can meet this standard.

The emissions found by EPA were as follows: for carbon monoxide, 10.6 grams per brake horsepower-hour (g/b-hp/hr), compared to a standard of 15.5; for nitrogen oxides, 1.4

g/b-hp/hr (compared to 5.0); for particulates emitted from urban buses, .02 g/b-hp/hr (compared to 0.1 for urban buses and 0.25 for other heavy-duty diesel engines in 1991 and 0.1 for all heavy-duty diesel engines in 1994); and for hydrocarbons 1.2 g/b-hp/hr (compared to 1.3). The hydrocarbon emissions were predominantly non-reactive hydrocarbons, i.e., they have been found not to interact chemically in the atmosphere and, therefore, are not precursors of ozone formation.

The above-referenced data involve heavy duty vehicles that are both newly manufactured and dedicated to natural gas use only. However, conversions of existing vehicles, including light duty vehicles as well as heavy duty vehicles, can also yield lower emission reductions in many cases.

Conversion of gasoline or diesel fueled vehicles to natural gas would reduce carbon monoxide emissions by up to 99%; can reduce nitrogen oxide emissions by up to 65%; and/or can reduce reactive hydrocarbon emissions by up to 92%. Actual emissions reductions achieved depend upon a large number of factors, including tuning, age and design of the vehicle, and the condition and technology of the gasoline emissions controls and natural gas conversion kit.

Due to the current drought and recent temperatures higher than historical norms, carbon dioxide has received a good deal of attention as a potential contributor to the global "greenhouse effect." Assuming that carbon dioxide

plays a role in creating the greenhouse effect, the Congress may want to exercise great caution in the incentives it provides for increased use of fossil fuels for transportation purposes. That is, reductions in vehicle emissions of carbon monoxide, hydrocarbons, and nitrogen oxides should be coupled with carbon dioxide emissions that are, at worst, no higher than such emissions from conventionally-fueled vehicles.

Natural gas as a vehicle fuel has the capability to reduce emissions of carbon monoxide, hydrocarbons, and nitrogen oxides as discussed above while also reducing carbon dioxide emissions, as compared to gasoline vehicles. In fact, emissions of carbon dioxide from NGVs are only about 75 percent of such emissions from gasoline vehicles.1/

Demonstration Projects

New York City has the highest density of bus traffic of any city in the United States, and with the single exception of Mexico City, in North America. In New York, there are 6,000 buses -- all diesels -- on the streets every day, and the total metropolitan area has about four times that many.

Because of the concentration of buses (almost all of which use diesel fuel) in urban areas, they represent a reasonable target for efforts to improve air quality. Before lead was banned from most gasoline, the diesel was looked upon as dirty, but safe. Later studies have shown

that diesels emit minute particulates, so small they can penetrate the natural defenses of the body and deposit carcinogenic chemicals on the tissue of the lungs.

Pollution from buses is substantially grater than that from trucks or cars. Buses create clouds of pollutants as they stop and go, subjecting pedestrians and motorists to particularly hazardous conditions. For these reasons, buses represent an important source of pollutants that should be targeted by air quality improvement measures. The Environmental Protection Agency appears to have taken that view.

Brooklyn Union agrees with EPA that buses should be targeted and believes that natural gas buses provide the best alternative to improve emissions from buses. For this reason, Brooklyn Union has, somewhat reluctantly, entered into the bus business.

EPA found an opportunity to demonstrate a case for using methanol as an alternative fuel when General Motors was cited for violating the Clean Air Act in the late 1970s. In a settlement, GM agreed to build six buses to operate on methanol and give them to the City of New York for testing.

Brooklyn Union believed that natural gas could make valuable contributions to air quality as an alternative fuel also. Therefore, we commissioned the first two buses in North America to operate solely on natural gas. Because Canada had been moving toward natural gas as a vehicular

fuel for several years, we went to Fiba-Canning in Toronto to design the engine. We ordered the buses from Bus Industries of America in Oriskany, New York.

In discussing the use of the natural gas engines with officials of the EPA, Brooklyn Union determined that the natural gas bus engine should be tested in a reputable laboratory. The resulting emission test results were outstanding, particularly in regard to nitrogen oxides, which are the most difficult of all to control. The test engine was then sent to the EPA test facility in Ann Arbor for further emissions testing. The results, as discussed above, were also excellent.

Of special interest is the test measurement of hydrocarbons. Our natural gas engine produces less hydrocarbons than the ceiling for this pollutant, but EPA is being asked to differentiate between reactive and nonreactive hydrocarbons. Since more than 80% of our hydrocarbons are nonreactive, this would nearly eliminate this as a pollutant.

As to particulates, natural gas engines emit close to zero.

The two Brooklyn Union natural gas clean air buses were dedicated to New York City service by Mayor Koch on July 7. They are now being instrumented for evaluation in every conceivable regard, and results will be available over a three year period in revenue service.

We do not mean that three years must elapse before we know enough to recommend this fuel. The Toronto Transit Commission examined our buses and has ordered 25 units as a start toward replacing 130 trolley buses, which in turn, according to Chief General Manager Allan Leach, may lead to replacing all 1,500 diesel buses in Toronto.

The buses have already received more than a few endorsements. Recently, Secretary of Energy John Herrington referred to the emissions of the bus displayed by Brooklyn Union at the World Gas Conference in Washington, and said that the natural gas bus provides "cleanliness beyond what any Clean Air Act ever envisioned."

Supply of Natural Gas

Natural gas is an energy source with a positive long-term supply and price outlook. The domestic supply of natural gas is fully sufficient to meet future demands. The Energy Information Administration (EIA) estimates proved reserves of gas in the lower-48 states at year-end 1986 to be 159 Tcf.[2/] According to estimates from the latest Potential Gas Committee (PGC) assessment,[3/] conventionally recoverable gas at year-end 1986 in the lower-48 states (including proved reserves) was 620 Tcf. Thus, the remaining recoverable resource would provide nearly a 50 year supply of gas at consumption rates experienced in 1987 (approximately 16 Tcf). As noted in its Energy Security Report, the Department of Energy found that a 200 year

supply of natural gas exists in the country if the gas from unconventional domestic sources is included.4/ This unconventional gas will yield significant production by the turn of the century.

A more recent DOE study on the potential natural gas resource base in the lower-48 states concluded that there are vast supplies of natural gas that can be recovered using existing technology.5/ According to DOE, there is a supply of 1,059 Tcf of gas available by using technology currently employed in the industry. Of this supply, 800 Tcf can come from conventional sources and 259 Tcf can come from unconventional sources such as low-permeability reservoirs, coal bed methane, and shale gas.

Moreover, since the transmission and distribution infrastructure is already in place, a safe public refueling system can be made operational in a short period of time.

Projected Transportation Use of NGVs

Under our most optimistic scenario (potential case), A.G.A. projects that the nationwide stock of NGVs may reach 1.3 million in the year 2000 and 4.1 million in 2010. Under another set of assumptions (attainable case), projections are for 300,000 NGVs to be on the road in the year 2000 and 1 million by 2010.6/

The underlying assumptions for the potential case include the following: national recognition of the environmental benefits associated with NGVs and corresponding movement to reduce pollution hazards through more widespread use of NGVs; technology development that allows increased driving range; successful R&D that results in lower unit conversion costs; manufacturer commitment to factory-built NGVs; and a gasoline and diesel/compressed natural gas (CNG) price ratio of 2:1. Implicit in these assumptions is a major push by the Federal Government to encourage the use of NGVs to attain air quality improvements.

By comparison, the attainable case represents a scenario in which the growth of NGVs is fostered primarily by economic considerations rather than environmental or other national policy concerns. The underlying assumptions for these projections include: successful R&D investments that will lower unit conversion costs; initial market penetration into bus transportation and heavy-duty truck transportation; and a gasoline and diesel/CNG price ratio of 1.5:1.

These projected prices of CNG compared to gasoline or diesel may appear to be optimistic at first glance. However, these levels are attainable for the commodity. A true and full reflection of the economics of using natural gas as a vehicle fuel should be obtained by using a life cycle cost basis, which requires the inclusion of the cost

of conversion and compression. We believe, on a life cycle cost basis, CNG is competitive with gasoline and diesel fuel, but should more properly be compared with other alternate fuels such as methanol.

Both converted vehicles and factory-built vehicles represent significant portions of total NGVs on the road under the potential and attainable cases. Under the potential case, conversions of gasoline and diesel fueled vehicles would total 82,500 and 5,824, respectively, by the year 2000. Manufacturer commitment to factory-built NGVs is reflected in the sales of such vehicles which are projected to equal 173,324 by the year 2000.

Under attainable case projections, conversions of gasoline and diesel NGVs would be 27,500 and 4,368, respectively, by 2000. By that year, sales of factory-built vehicles would be nearly 24,000.

A profile of the projected NGV fleet reveals that trucks and vans make up a sizable portion of the fleet -- 45 percent -- under both the potential and attainable cases. Buses (operated, for example, by school districts or metropolitan transit authorities) would represent 45 percent of the NGV fleet under the attainable case and 35 percent under the potential case. The percentage is lower in the potential case due to a penetration of the sedan market under that scenario (and a correspondingly higher proportion of sedans in the total fleet).

Although more widespread use of NGVs would represent an opportunity for increased sales by the gas industry, the increased demand for natural gas would be slight when viewed as a percentage of total end use demand. Under the attainable case, NGVs would use 0.1 Tcf in the year 2000 and 0.3 Tcf in 2010. This would represent only 0.7 percent and 2 percent, respectively, of the end use demand in those years. The demand would increase somewhat under the potential case, to 0.3 Tcf in 2000 and 0.9 Tcf in 2010. However, these figures would still only constitute 2.1 percent and 5.9 percent of end use demand.

The United States, by encouraging the more widespread use of NGVs, would be following a trail already blazed by other countries. Italy currently has about 300,000 NGVs on its roads. NGVs have been used in that country since the 1940s. The refueling system in Italy relies on about 140 large stations with a very high compression capacity and about 100 "satellite" filling stations. The large filling stations supply the "satellite" stations with natural gas transported over surface roads.

New Zealand has over 100,000 NGVs. More natural gas is sold for transportation purposes in New Zealand than for any other sector of the market.

Canada has been following an aggressive program for the last several years to convert private vehicles and fleet vehicles to natural gas. One of the key elements to the Canadian program has been strong support from the

government, which has been subsidizing vehicle conversions and has a heavy R&D program to improve fueling systems. This solid government support has produced a refueling system of well over 100 public refueling stations.

By comparison with these other countries, particularly Italy, the United States would have little difficulty in operating a comprehensive refueling network through our nationwide pipeline system. The relatively simple installation of compressor stations for refueling could be accomplished throughout the Country.

Fuel Cost Advantage of Natural Gas

Vehicles that are currently in service, or that will be manufactured in the near future, would require conversion to the capability to use natural gas as a fuel. If newly manufactured gasoline or diesel vehicles do not meet the emission standards that become effective for 1991 or 1994 models, they could be converted to NGVs to comply with the standards. The capital cost incurred in converting a vehicle can be subsequently recovered through lower fuel costs. For a typical vehicle fleet, NGVs -- when compared to gasoline vehicles -- could offer an 11 percent reduction in life cycle operating costs.[7/]

This economic advantage over gasoline exists despite the fact that the life cycle operating costs for NGVs include all vehicle conversion costs, all costs of compressor station installation, all fuel expenses and all

other operating expenses. If public refueling stations become widely available, the reduction in life cycle operating costs could become even greater since the cost of compressor station installation might not be borne by fleet operators.

Conclusion

As Members of this Subcommittee are aware, many metropolitan areas across the country are not in compliance with the Clean Air Act standards for carbon monoxide and ozone. Mobile sources are the principal cause of this pollution. Alternative fuels for motor vehicles have been widely recommended as a strategy for solving this air pollution problem.

The Clean Air Act legislation which has been proposed in each House includes requirements for noncompliance areas to take steps to use alternatively fueled vehicles. Legislation has also passed both Houses which provides incentives for automobile companies to manufacture alternatively fueled vehicles. The House version of this legislation authorizes government demonstration projects for these vehicles. We support this legislation.

We also believe that your Subcommittee, with its jurisdiction over DOE transportation and R&D, is in an ideal position to advance the development and commercialization of alternatively fueled vehicles, especially in natural gas fueled diesel buses and trucks. Federal support of R&D on

diesel/NGV engines and on gas storage technologies would help to expedite the development of engines designed to run most optimally and efficiently on natural gas. Further development of gas storage technologies would improve the convenience and logistics of natural gas fueled vehicles.

Particular research areas that would benefit from federal support would include improvements in engine technologies that will facilitate lower emissions of nitrogen oxides and hydrocarbons from natural gas/diesel engines. In particular, catalytic conversion technology does not operate effectively on the chemical components of natural gas with respect to nitrogen oxides. Either a catalytic converter that is capable of reducing nitrogen oxides emissions should be developed or a method of mixing air and natural gas outside of an engine's combustion chamber should be found.

With respect to hydrocarbons, A.G.A. points out that the Gas Research Institute is conducting research aimed at meeting the standards applicable to heavy-duty diesel engines. The R&D focus of GRI will be on advanced designs, fuel management, and injection techniques; on advanced ignitions systems; and on storage media and containment vessels for both high and low-pressure storage. The research should provide a sound basis for a longer term R&D on medium and light-duty vehicle engines and fuel and technology issues that may require longer development and certification schedules.

The natural gas industry maintains a service infrastructure that can deliver this fuel to almost any part of the country with only relatively slight adjustments necessary to furnish natural gas as a vehicle fuel. In summary, the advantages that natural gas and NGVs can provide to the country should not be ignored as the Congress deliberates modifications of the Clean Air Act.

FOOTNOTES

1/ Source: Gushee, David E., Carbon Dioxide Emissions from Methanol as a Vehicle Fuel (Washington, D.C., Congressional Research Service, January 4, 1988).

2/ Energy Information Administration, U.S. Crude Oil, Natural Gas and Natural Gas Liquids Reserves, 1986 Annual Report (1987).

3/ Potential Gas Committee, Potential Supply of Natural Gas in the United States as of December 31, 1986 (1987).

4/ U.S. DOE, Energy Security, A Report to the President, DOE/S-0057 at 116 (March 1987).

5/ U.S. DOE, An Assessment of the Natural Gas Resource Base of the United States (May 1988).

6/ American Gas Association, The Outlook for Gas Demand in New Markets: 1986-2010 (August 1986).

7/ American Gas Association, An Economic and Efficiency Comparison of Alternative Vehicle Fuels: 1987 Update (September 22, 1987).

Mr. McCURDY. Thank you, Mr. Matthews, for your testimony.

There were a couple of things within each of your testimonies that I wanted to follow up on. First of all, Mr. Fisher, I was interested during the testimony by Mr. Matthews, regarding dual use diesel engines, that is dual fuel use. Whether you can have it. Are you doing research, or is there much of a conversion problem? What are difficulties of dual fuel systems for a current fleet of heavy trucks? Tell us some of the technology there as you see it.

Mr. FISHER. For dual fuel. For dual fuel I'm assuming you're meaning diesel fuel in combination with either natural gas or methanol.

Mr. McCURDY. Methanol or something.

Mr. FISHER. Besides the complexity of the fuel system and the control system required when you have a dual-fueled vehicle, when you're burning diesel fuel, I see that 0.1 particulate standard becoming a challenge. I see some problems in meeting the standards with a dual-fueled vehicle, and also the complications of having to carry two on-board fuel systems.

Mr. McCURDY. Well, then what do you think the future of a methanol truck is, or natural gas engine in the future? I mean, I guess the bus engines that you're talking about in New York are—

Mr. MATTHEWS. Those are dedicated.

Mr. McCURDY.—are gas.

Mr. MATTHEWS. They're gas only, right.

Mr. McCURDY. Yeah, they're gas only, so they've been converted. But in the diesel area, are you all doing research in this other area, or are you moving that direction?

Mr. FISHER. Let me answer it this way. For the heavy-duty transit bus area, I think alternate fuels make some sense, because you do have a captured fleet. When you try to transfer this technology to the general heavy-duty truck population in general, you bring in other problems. And probably the biggest problem is the fuel infrastructure.

Mr. McCURDY. The distribution or availability of gas stations or whatever?

Mr. FISHER. That's the major problem that I see with that.

So, from Detroit Diesel's standpoint we don't see methanol or natural gas expanding outside the urban areas. Now, you may see some expansion to captured fleets, for example, refuse trucks, or some municipal trucks where they're always close to a central fueling location, alternate fuels such as natural gas or methanol, I think, make sense for those type vehicles.

Mr. McCURDY. Mr. Boyd, I sense that when Mr. Bailey was describing some of his concerns and Washington, D.C.'s concern about the safety of some of the alternative fuels, I didn't know if you were just shooing away flies or you were shaking your head because you disagreed, but do you care to address that one issue, and perhaps Mr. Fisher, and I think Mr. Matthews took issue with it? I'm just curious about how volatile and how more dangerous are these alternative fuels that California's looking at, that you're pushing for in some research?

Mr. BOYD. I probably shouldn't have been so graphic, but I wasn't swatting flies, and with all due respect to Mr. Bailey we've not even had the opportunity to meet, that I think why I was shak-

ing my head was a sudden concern [illegible] which was reemphasized, that we don't have good communic[illegible]between the various infrastructures involved in this whole [illegible] that in my mind there is quite a bit of research knowledge and data available relative to a lot of the issues Mr. Bailey brought up. And that, true, there are always unresolved questions remaining on the table, but we really do need to have better communication amongst all the parties involved, because I do not feel as strongly about the safety issue. We have done an awful lot of work on the safety issue, and I'm sure some of the engine manufacturers have, and there are questions relative to both natural gas and methanol.

We recommend them both. We think there are nitch markets for both, particularly with respect to the dedicated fleets. Right now we're running a large number of light-duty vehicles on what is considered to be neet, or pure methanol, but it isn't. It's M85, as it's described. It's 85 percent methanol, and 15 percent unleaded gasoline. And that is for two reasons. It is to address what they call a cold-start problem, where you have trouble igniting methanol at low temperatures. Well, that's not a California dilemma, but it's also for the flame visibility problem in the event of fire. There's no evidence to indicate that there's any more likelihood of fire on board a methanol vehicle than on board a gasoline vehicle. It is true, there is an invisible flame. Of course, they've been using methanol as a racing fuel for decades. And of course, that's a very high risk business, but there's an awful lot of safety involved in it. And except for the moving vehicles on the track, you don't see any evidence of storage and fueling concerns.

I've been driving a major manufacturer's neet methanol vehicle for at least two years now, and fueling it myself, regularly. And we have a large network in California and getting even more, and we just don't think that there is that large safety concern. And some people get into the toxics aspects of methanol. Methanol is no more or less toxic, in my opinion, than gasoline. Neither one of them is good for you; they'll both kill you if you drink them; methanol might kill you faster; you might go blind first, but you wouldn't—you know, you'll treat them both the same way, with respect and they'll treat you fairly. So there is an awful lot of data and I just believe that the transit districts need to talk among themselves, perhaps, or to the Southern California Rapid Transit District, perhaps the largest in the nation, is extremely excited about, and encouraged about the idea of alternative fuels.

And for all—I don't—I'm glad to see Mr. Matthews advocating gas, because I do think it's somewhat a product of who got there first, but most of the studies of the past have admittedly shown if you take in all the economics, and all the infrastructure, and the other issues, that methanol does end up at the top of the list. But that's not to say it shouldn't be restudied. In California, we are restudying it, which is why I have reached out recently to a lot of the gas areas. And I've gone to Ontario in Canada, where they are doing a lot of work, and I would encourage a look into the natural gas work up there. But there is a lot of data available, it just needs to be brought to the attention of a lot of the people. And natural gas is extremely viable, as far as I'm concerned, but we may have to carve out nitch markets.

If we demand too much of methanol, you will get into producing methanol from coal. You don't have to, you don't have to for a long, long time, because there is so much natural gas available with which to make methanol, or with which to use in the manner that Mr. Matthews indicates. There are problems with fueling natural gas vehicles that he didn't mention. It's a very slow process; many bus districts have concern with the turnaround. So, I mean, you have to put all the issues out on the table. And with regard to CO_2, since it was broached, my experts tell me, before we get to methanol from coal, there is a net benefit, as Mr. Wilson indicated, with regard to the production of CO_2. You can take some of the flared natural gas throughout the world and dedicate it to methanol. Flaring the gas is making NO_X and CO_2. There is a net benefit in our opinion, but it doesn't address the fuel dependance issue. Yes, we are dependant on the foreign sources at present. There's an incredible amount of natural gas in—

Mr. McCURDY. My district.

Mr. BOYD.—in your district—injected back into the ground in Alaska and what-have-you. There's room for everybody is the way we look at it.

Mr. McCURDY. Mr. Bailey, I wasn't really picking on you, if you care to respond, or follow up, you're certainly welcome to.

Mr. BAILEY. I think I'd like to. My concern is a people concern. I've been involved in public transit now for nearly 30 years, and I've seen a lot of very serious things happen. I know that in handling of some fuels that tend to be fuels with very low flash points, that some very serious things have happened. I do not share Mr. Boyd's concern that it's not a very serious thing. I think it's very serious.

We have people that would have to handle that. People that would ride the vehicles that need to have the certainty that we have total control of what is in that vehicle. That's what my concern is.

Mr. McCURDY. Well, perhaps the relevant Government agencies, plus those that are performing research could address this, and make this a part of their data when they're reporting on research. The safety factor that is. And I think there has to be improved communication, there's no question. And I think part of the communication is alleviating some of the concerns and perhaps there has to be some additional training, or just some general education.

If other countries have had this success with it— some of the articles I've seen about other countries having a lengthy experience with both methanol and natural gas, that they've not had the accident rates that one might assume. Some of us grew up around a lot of farms, there was a lot of natural gas powered pick-up trucks and trucks out there on the road for years. I can't recall any major accidents with that either.

But anyway, that's something that probably should be addressed, and you're right in raising that concern, and I think that it's incumbent upon those that are advocating this that they address that.

I only had one last question, and that was for Mr. Boyd. I'm curious on your potential retrofit program on collectors and traps, how

do you all do it out there? How do you get away with a retrofit or a retroactive type of device?

Mr. BOYD. Well, as I indicated it really is pure research right now. Many years ago when California recognized the difficulties with diesel, we started down some parallel paths. One was to work on the diesel engine, and the control of the diesel engine. And the other was to look to alternative fuels, be it methanol or otherwise. We looked to both developments relative to new diesel engines, and you've heard of engine modifications and the addition of trap technology, and we looked at the fact that many of these vehicles are on the road for a long time.

We had one research project with a particular manufacturer's research trap intended for retrofit purposes, and it frankly was not as successful as we would have hoped. As I indicated, we're engaged in yet another research project now, and I'm aware of yet other ones under way, that perhaps show promise. It is pure research and development right now. We're not sure. And I would say it's still a 50/50 call. I'm hopeful that technologically the problems could be solved for all the reasons I cited, and the fact that you'd get immediate benefits, but we're not betting on just one horse right now. We're still looking at engine modifications, retrofits, and alternative fuels, and I don't think we've decided yet. And I'd really like to encourage the Federal Government to do more research on advanced diesel engines to lower NO_x, and not to just walk away from diesel fuel. We have to look at fuel composition and what you can do to the diesel engine, as well as deal more with this duel fuel issue.

We are very interested in dual fuel. It could conceivably be someday that because of California's air quality problem, and it's being added to the tremendous numbers of people and the expanding economy, and the tremendous numbers of vehicles that we may have to deal with some kind of dual fuel capability for truck tractors. It's either that, or the possibility of you bring your product into the State in a diesel vehicle, you park it at the border at some kind of marshalling yard, and an alternative fuel, or electrically powered vehicle takes it the rest of the way. I mean, that's pretty far out, but unfortunately in Los Angeles we're dealing with the far out. I mean, we've just revealed the fact that—

Mr. MCCURDY. In more ways than one.

Mr. BOYD. In more ways than one.

[Laughter.]

Mr. BOYD. I'm from Northern California, so I can say that. I can hardly wait to get back to Northern California to get away from this Los Angeles situation.

In any event, they've just unveiled their plan for 20 years, and I would concur, as a professional in this business, you can't clean up Los Angeles in anything less than 20 years doing everything possible and then some. And so we're talking about these kinds of things, and I encourage all these gentlemen to do everything they can, because we need everything that they can do.

Mr. MCCURDY. I've spent a lot of time in Central America, and Mexico. And I can assure you if you think L.A. has problems, you ought to go to Mexico City, or any major city in Latin America.

The buses are a way of life, but the buses they have, have more than nine lives. It's pretty primitive.

The gentleman from Maryland, because of a natural phenomenon, breathes cleaner air. I mean, he just does. It's cleaner up there or closer, or something. I don't know. It's just higher anyway.

[Laughter.]

Mr. MCMILLEN. But the ozone problem—

Mr. MCCURDY. You've got the ozone problem.

Mr. MCMILLEN. Thank you, Mr. Chairman.

I had a couple questions to ask Mr. Bailey, and I welcome Mr. Bailey to this hearing representing the Washington Metropolitan Area Transit Authority. I want to compliment you and commend you on your distinguished service to our Nation's Capitol, and to my congressional district. So, I thank you very much, and just had a couple of questions on your testimony.

What would be the effect of delaying bus purchases if diesel engines are obsolete and alternative fuels are not a viable means for meeting the 1991 standards?

Mr. BAILEY. Mr. McMillen, we have the oldest, one of the oldest fleets in the country. Our fleet averages somewhere between 10 and 11 years old. We have some buses as old as 19 years. Our bus procurement currently is running with a replacement of about 78 buses a year. I would imagine that if in order to comply with the 1991 regulation, if we had to stop buying buses as a result of that, we would be in very, very deep trouble. Trouble to the extent that the reliability issue would falter to the extent that for every bus that we couldn't operate, you can imagine 40 or 50 additional cars on the street.

Mr. MCMILLEN. Are there unique problems that Washington Metro would encounter in switching to alternative fuels?

Mr. BAILEY. Yes. We're talking about something that would be a significant financial impact on the jurisdictions. Currently, we have a significant subsidy that is provided by the jurisdictions because of the amount of money that comes out of the fare box, that obviously they're making up the difference. I would see the impact mainly either in the way of higher fares, or increased subsidy.

Mr. MCMILLEN. What would be the ramifications of Washington Metro adding some alternative fuel buses to the fleet? Would the authority be able to convert some of its bus garages and train a portion of its mechanics, or would the conversion have to be system-wide?

Mr. BAILEY. Well, because of the manner in which our buses are scheduled to operate, I would think that we would have about 800 plus mechanics that we would have to train, as well as the fire departments in all the jurisdictions would have to be trained. And we would talk about a fairly significant capital investment in finding ways to house alternative fuels, special fuel lanes, things of this nature.

Mr. MCMILLEN. It's my understanding, you mentioned it that in addition to the fare box with the operating subsidies from the localities, that's the extent of your financing. To what extent would this contribution, the operating subsidy increase if Washington Metro purchased buses that use alternative fuels? What would be the probability of that increase in your view?

Mr. BAILEY. Well, I have no idea at this point what the cost of an engine that utilizes the alternative fuel would be at this time. I understand that we're talking about something that would be a fairly significant cost. If, as some of the learned gentlemen have indicated today, about particulate traps and things of this nature of a lesser cost, we're talking about something that would not be as high a cost, and yet it's not yet available to industry. So I guess the cost is just something that is picked out of the air. So, we're talking about a very significant cost.

Mr. MCMILLEN. Very significant cost.

Mr. BAILEY. Yes.

Mr. MCMILLEN. Thank you.

Thank you, Mr. Chairman.

Mr. MCCURDY. Thank the gentleman.

Gentlemen, thank you—oh, Mr. Matthews?

Mr. MATTHEWS. I can't let that last comment stand, I think, because we have the experience certainly of our buses. I think any bus manufacturer, or engine manufacturer, would tell you and the kind of adaptation we made where we had a dedicated vehicle, although clearly there was some special research that went into the effort to adapt the engine. But the only incremental cost to a bus is the cost of the cylinders themselves to store the methane, in our case, or the compressed natural gas. Seven tanks cost about $7,000, on a bus that has a total cost of between $125,000 to $150,000 per bus, I don't consider that cost substantially incremental compared to the overall cost. And that doesn't offset the savings and maintenance that you would have, less oil changes, et cetera.

Mr. MCMILLEN. Would you comment on the training and some of the—

Mr. MATTHEWS. The training—Mr. Bailey makes a good comment. I think safety is an issue, and I think it is one of communication and training. However, that's not to say I'm sure if Mr. Bailey has creative resources they could get their local utility to provide some of that training at no cost to the transit authority. We have trained our own mechanics—I mean, there is an issue of safety out there. We have trained them, our same mechanics that handle our total fleet, handle these with a relatively small amount of training. There have been no problems.

But we had to go through that education prospective. I wish I had a film that you could all see. It takes about 10 minutes, but it shows a natural gas vehicle being dropped by a crane from 100 feet in the air, right onto the ground. It shows a policeman shooting a rifle at the cylinder tank itself. It shows a stick of dynamite—the most incredible situations, the tank isn't damaged at all. There is no explosion, there is no fire. I think probably visibly that gives more assurances in showing that kind of a film to people regarding the safety issues.

But it is an issue that has to be addressed, and I think we've done it from the experience of the 500,000 vehicles in effect, and you can overcome it.

Mr. MCCURDY. Perhaps we've performed a marriage today where Mr. Matthews and Mr. Bailey would be willing to sit and talk to each other about the—

[Laughter.]

Mr. McCURDY.—potential for the Washington Metropolitan Area to consider a test by the AGA, and if Mr. Bailey would like to get together, maybe there's some kind of arrangement that could be worked out.

Next year when you testify you can tell us how it's working.

Mr. BAILEY. That's a deal.

Mr. McCURDY. You'd be willing to entertain any proposals, wouldn't you?

Mr. MATTHEWS. We certainly would.

Mr. BAILEY. Certainly.

Mr. McCURDY. If not the committee of jurisdiction, perhaps if someone else was willing to pay for it, maybe they'd be willing to experiment too, and it might be a wave of the future.

Mr. FISHER. Mr. Chairman, could I make one comment on that?

Mr. McCURDY. You want to join them, too, Mr. Fisher?

Mr. FISHER. Sure.

[Laughter.]

Mr. McCURDY. We'll let you pay for part of it, too.

Mr. FISHER. Okay.

I wanted to comment on the cost of traps. Mr. Wilson earlier had indicated probably in the area of $1,000. The perspective of Detroit Diesel, an engine manufacturer, I think that's way understated. Industry— we're on record as probably $4,000 and that may be on a low cost. I think industry is more on record in the range of $4,000 to $7,000 for a particulate trap system. So I really look at an exhaust aftertreatment system to be as expensive, if not more expensive than possibly conversion to an alternate fuel.

Mr. McCURDY. It would be $40,000 if you were selling them to DOD.

[Laughter.]

Mr. McCURDY. Gentlemen, again, we thank you for your testimony. And I wasn't totally facetious when I was suggesting that perhaps some primary principals here could visit about the opportunity in the future to expand the research base in this area.

This chairman thinks this is a serious issue. And I believe that it's one that is a national concern, and it doesn't have to be in the major metropolitan areas. My hometown of Norman, Oklahoma, in Cleveland County, is close to being out of attainment also. So it can happen out there with the average wind of about 12 miles an hour, too. So I think this is something we ought to be working on.

I appreciate your open-minded approach, and hope that we will continue to work in this direction. Thank you.

Our next witness is Mr. Harold Jenkins, and I believe he has some people who want to join him at the table, Mr. Obert and Mr. Heinle.

STATEMENT OF MR. HAROLD JENKINS, GENERAL MANAGER, CAMBRIA COUNTY TRANSIT SYSTEM, JOHNSTOWN, PENNSYLVANIA, ON BEHALF OF AMERICAN PUBLIC TRANSIT ASSOCIATION; ACCOMPANIED BY: MARK J. OBERT, VICE CHAIRMAN, APTA ASSOCIATE MEMBER BOARD OF GOVERNORS, VICE CHAIRMAN, THE FLXIBLE CORPORATION, DELAWARE, OHIO; AND GEORGE W. HEINLE, CHAIRMAN, APTA BUS EQUIPMENT AND MAINTENANCE COMMITTEE, VICE PRESIDENT AND GENERAL MANAGER, NEW JERSEY TRANSIT BUS OPERATIONS, INC, MAPLEWOOD, NEW JERSEY

Mr. JENKINS. Thank you very much, Mr. Chairman, for giving us the opportunity to present our testimony today. With me, joining me at the table today is Mr. Mark Obert. Mark is the Vice Chairman of the Flxible Corporation from Delaware, Ohio, and also serves as the Vice Chairman of the APTA, American Public Transit Association's Associate Member Board of Governors. And George Heinle, to my left, who is the Vice President and General Manager of the New Jersey Transit Bus Operations, one of the four top transit agencies in the United States. George is also Chairman of the transit association's Bus Equipment and Maintenance Committee. So, I have with me two high technology witnesses for questions later.

The American Public Transit Association welcomes this opportunity to present testimony before the subcommittee on the issue of Federal Air Quality Emission Standards.

As you may know, Mr. Chairman, APTA is the international association of operating mass transit systems and private-sector manufacturers, suppliers and consultants. Our transit system members serve 95 percent of all transit riders in the United States.

The mass transit community has been in the forefront of this nation's efforts to assure the cleanest possible environment, especially in our cities. While in the past some have seem urban bus emissions as a visible element of the challenges we face, more recent initiatives in Congress have pointed to more and better transit services as the key to less automobile traffic and a cleaner, more healthful urban environment. Proposed Clean Air Act amendments are perhaps the most prominent among these.

The challenge we face is simply this: How can the mass transit community, its manufacturers and operators, meet the 1991 EPA emission standards most effectively without aggravating the problem we want to solve and without creating an economic and technological backlash in our industry?

There is no simple, easy answer. But APTA members, through our Bus Equipment and Maintenance Committee and with the help of our associate members, have led the search by promoting research, monitoring the development of diesel engine technology and exploring the promises of alternative fuels.

Just as an aside, today one of our bus experts in the industry is in Dallas, Texas right at this very moment attending the American Gas Association's symposium on gas technology. We've also—our national association is sponsoring an alternative fuel emission workshop in Tacoma, Washington early next month. So the transit

association is totally aware and totally involved in the research and development of this technology.

Our efforts, however, have been impeded by the two different deadlines to meet exhaust emission standards in the regulations. Urban buses must comply by 1991, but heavy-duty trucks have until 1994. High annual engine sales for trucks, as opposed to relatively low sales for transit buses, are what is really driving the timetable for compliance. We are, in a sense, the test case or the rolling laboratory for the coming changes in engine and fuel technology.

Yet needed diesel engine improvements, including particulate traps, may not be ready for service by 1991. And the jury is still out on the long-term merit of alternate fuels like methanol, propane and compressed natural gas. Some of our members believe that by 1994, modified diesel engine technology will help us meet the standards, others are betting that new fuel types are the answer.

In the meantime, testing goes on. Demonstration projects are underway in the lab and on the road on the ability of trap oxidizers to cut down on particulates. And throughout the nation, alternative-fueled buses have been put into service.

In cooperation with EPA, New York City's Metropolitan Transportation Authority has a full methanol testing program underway. Smaller test projects exist in Seattle, Jacksonville, and in Southern California. Later this year, Orange County, California will test propane-powered buses. And in Los Angeles and Tacoma, Washington, they're testing the promise of natural gas as a vehicle fuel.

Our neighbors in Canada are in the forefront of efforts to test natural gas. The Toronto Transit Commission has embarked on a major-scale demonstration project that may lead to the conversion of its entire 150-vehicle trolley-bus fleet. At first, 20 buses will be tried.

Aside from the technical issues surrounding alternate fuels there are a host of economic ones we must face. These include fuels handling and storage, availability, cost and the effects on vehicle weight. They will directly affect our capital and operating costs, and therefore, the price the public will pay for service.

Faced with these uncertainties, our fear is that many transit authorities may choose to wait and see, to postpone, against their better judgment, vehicle purchases until the answers to technology and cost questions become more certain. Such a policy could delay normal replacement schedules, cause economic hardship in the supply side of our industry, and keep older buses in service, thereby risking the advancement of our clean air objectives.

We intend to keep exploring these issues with your subcommittee, and with other committees of jurisdiction, Energy and Commerce and Public Works and Transportation, and with the old and the new Administrations. Continuing dialogue may well lead us jointly to a view that a single timetable for compliance for buses and trucks is what is really needed to advance our goals of a cleaner environment and viable mass transit services. In the interim, there should be a continuation of controlled testing of diesel technology and alternate fuels.

Thank you, Mr. Chairman, for your leadership and concern with these important issues. My colleagues and I are prepared to answer any questions you might have.

[The prepared statement of Mr. Jenkins follows:]

STATEMENT OF THE

AMERICAN PUBLIC TRANSIT ASSOCIATION

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

HONORABLE DAVE McCURDY, CHAIRMAN

JULY 13, 1988

2325 RAYBURN HOUSE OFFICE BUILDING

WASHINGTON, D.C.

AMERICAN PUBLIC TRANSIT ASSOCIATION
1201 NEW YORK AVENUE, N.W.
WASHINGTON, D.C. 20005

AMERICAN PUBLIC TRANSIT ASSOCIATION

STATEMENT BEFORE THE

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WITNESS TEAM

Harold C. Jenkins
Vice Chairman-Procedures, APTA Legislative Committee
General Manager, Cambria County Transit Authority
Johnstown, Pennsylvania

Mark J. Obert
Vice Chairman, APTA Associate Member Board of Governors
Vice Chairman, The Flxible Corporation
Delaware, Ohio

George W. Heinle
Chairman, APTA Bus Equipment and Maintenance Committee
Vice President & General Manager, New Jersey Transit
Bus Operations Inc.
Maplewood, New Jersey

STATEMENT OF THE AMERICAN PUBLIC TRANSIT ASSOCIATION
BEFORE THE SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
OF THE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

GOOD AFTERNOON. THE AMERICAN PUBLIC TRANSIT ASSOCIATION WELCOMES THIS OPPORTUNITY TO PRESENT TESTIMONY BEFORE THE SUBCOMMITTEE ON THE ISSUE OF FEDERAL AIR QUALITY EMISSION STANDARDS.

AS YOU MAY KNOW, MR. CHAIRMAN, APTA IS THE INTERNATIONAL ASSOCIATION OF OPERATING MASS TRANSIT SYSTEMS AND PRIVATE-SECTOR MANUFACTURERS, SUPPLIERS AND CONSULTANTS. OUR TRANSIT SYSTEM MEMBERS SERVE 95 PERCENT OF ALL TRANSIT RIDERS IN THE UNITED STATES.

THE MASS TRANSIT COMMUNITY HAS BEEN IN THE FOREFRONT OF THIS NATION'S EFFORTS TO ASSURE THE CLEANEST POSSIBLE ENVIRONMENT, ESPECIALLY IN OUR CITIES. WHILE IN THE PAST SOME HAVE SEEN URBAN BUS EMISSIONS AS A VISIBLE ELEMENT OF THE CHALLENGE WE FACE, MORE RECENT INITIATIVES IN CONGRESS HAVE POINTED TO MORE AND BETTER TRANSIT SERVICES AS THE KEY TO LESS AUTOMOBILE TRAFFIC AND A CLEANER, MORE HEALTHFUL URBAN ENVIRONMENT. PROPOSED CLEAN AIR ACT AMENDMENTS ARE PERHAPS THE MOST PROMINENT AMONG THESE.

THE CHALLENGE WE FACE IS SIMPLY THIS: HOW CAN THE MASS TRANSIT COMMUNITY - ITS MANUFACTURERS AND OPERATORS - MEET THE 1991 E.P.A. EMISSION STANDARDS MOST EFFECTIVELY WITHOUT AGGRAVATING THE PROBLEM WE WANT TO SOLVE AND WITHOUT CREATING AN ECONOMIC AND TECHNOLOGICAL BACKLASH IN OUR INDUSTRY?

THERE IS NO SIMPLE, EASY ANSWER. BUT APTA MEMBERS, THROUGH OUR BUS EQUIPMENT AND MAINTENANCE COMMITTEE AND WITH THE HELP OF OUR ASSOCIATE MEMBERS, HAVE LED THE SEARCH BY PROMOTING RESEARCH, MONITORING THE DEVELOPMENT OF DIESEL ENGINE TECHNOLOGY AND EXPLORING THE PROMISES OF ALTERNATIVE FUELS.

OUR EFFORTS HAVE, HOWEVER, BEEN IMPEDED BY THE TWO DIFFERENT DEADLINES TO MEET EXHAUST EMISSION STANDARDS IN THE REGULATIONS. URBAN BUSES MUST COMPLY BY 1991, BUT HEAVY DUTY TRUCKS HAVE UNTIL 1994. HIGH ANNUAL ENGINE SALES FOR TRUCKS, AS OPPOSED TO RELATIVELY LOW SALES FOR TRANSIT BUSES, ARE WHAT IS REALLY DRIVING THE TIMETABLE FOR COMPLIANCE. WE ARE, IN A SENSE, THE TEST CASE OR THE ROLLING LABORATORY FOR THE COMING CHANGES IN ENGINE AND FUEL TECHNOLOGY.

YET NEEDED DIESEL ENGINE IMPROVEMENTS, INCLUDING PARTICULATE TRAPS, MAY NOT BE READY FOR SERVICE BY 1991. AND THE JURY IS STILL OUT ON THE LONG-TERM MERIT OF ALTERNATE FUELS LIKE METHANOL, PROPANE AND COMPRESSED NATURAL GAS. SOME OF OUR MEMBERS BELIEVE THAT BY 1994, MODIFIED DIESEL ENGINE TECHNOLOGY WILL HELP US MEET THE STANDARDS, OTHERS ARE BETTING THAT NEW FUEL TYPES ARE THE ANSWER.

IN THE MEANTIME, TESTING GOES ON. DEMONSTRATION PROJECTS ARE UNDERWAY IN THE LAB AND ON THE ROAD ON THE ABILITY OF TRAP OXIDIZERS TO CUT DOWN ON PARTICULATES. AND THROUGHOUT THE NATION, ALTERNATIVE-FUELED BUSES HAVE BEEN PUT INTO SERVICE.

IN COOPERATION WITH E.P.A., NEW YORK CITY'S METROPOLITAN TRANSPORTATION AUTHORITY HAS A FULL METHANOL TESTING PROGRAM UNDERWAY. SMALLER TEST PROJECTS EXIST IN SEATTLE, JACKSONVILLE AND IN SOUTHERN CALIFORNIA. LATER THIS YEAR, ORANGE COUNTY, CALIFORNIA WILL TEST PROPANE-POWERED BUSES. AND IN LOS ANGELES AND TACOMA, WASHINGTON, THEY'RE TESTING THE PROMISE OF NATURAL GAS AS A VEHICLE FUEL.

OUR NEIGHBORS IN CANADA ARE IN THE FOREFRONT OF EFFORTS TO TEST NATURAL GAS. THE TORONTO TRANSIT COMMISSION HAS EMBARKED ON A MAJOR-SCALE DEMONSTRATION PROJECT THAT MAY LEAD TO THE CONVERSION OF ITS ENTIRE 150-VEHICLE TROLLEY-BUS FLEET. AT FIRST, 20 BUSES WILL BE TRIED.

ASIDE FROM THE TECHNICAL ISSUES SURROUNDING ALTERNATE FUELS THERE ARE A HOST OF ECONOMIC ONES WE MUST FACE. THESE INCLUDE FUELS HANDLING AND STORAGE, AVAILABILITY, COST AND THE EFFECTS ON VEHICLE WEIGHT. THEY WILL DIRECTLY AFFECT OUR CAPITAL AND OPERATING COSTS AND THEREFORE THE PRICE THE PUBLIC WILL PAY FOR SERVICE.

FACED WITH THESE UNCERTAINTIES, OUR FEAR IS THAT MANY TRANSIT AUTHORITIES MAY CHOSE TO WAIT AND SEE, TO POSTPONE - AGAINST THEIR BETTER JUDGMENT - VEHICLE PURCHASES UNTIL THE ANSWERS TO TECHNOLOGY AND COST QUESTIONS BECOME MORE CERTAIN. SUCH A POLICY COULD DELAY NORMAL REPLACEMENT SCHEDULES, CAUSE ECONOMIC HARDSHIP IN THE SUPPLY-SIDE OF OUR INDUSTRY, AND KEEP OLDER BUSES IN SERVICE, THEREBY RISKING THE ADVANCEMENT OF OUR CLEAN AIR OBJECTIVES.

WE INTEND TO KEEP EXPLORING THESE ISSUES WITH YOUR SUBCOMMITTEE, AND WITH OTHER COMMITTEES OF JURISDICTION - ENERGY AND COMMERCE AND PUBLIC WORKS AND TRANSPORTATION - AND WITH THE OLD AND NEW ADMINISTRATIONS. CONTINUING DIALOGUE, MAY WELL LEAD US JOINTLY TO A VIEW THAT A SINGLE TIMETABLE FOR COMPLIANCE, FOR BUSES AND TRUCKS, IS WHAT IS REALLY NEEDED TO ADVANCE OUR GOALS OF A CLEANER ENVIRONMENT AND VIABLE MASS TRANSIT SERVICES. IN THE INTERIM, THERE SHOULD BE A CONTINUATION OF CONTROLLED TESTING OF DIESEL TECHNOLOGY AND ALTERNATE FUELS.

THANK YOU, MR. CHAIRMAN, FOR YOUR LEADERSHIP AND CONCERN WITH THESE IMPORTANT ISSUES. MY COLLEAGUES AND I ARE PREPARED TO ANSWER ANY QUESTIONS YOU MIGHT HAVE.

Mr. MCCURDY. Very good. Do the gentlemen have any comments directly, or a statement?

[Messers Obert and Heinle indicate that they do not have prepared statements.]

Mr. MCCURDY. Okay. Thank you, Mr. Jenkins.

I think I understand your statement regarding the two different dates for compliance. However, I think it was Mr. Boyd or Mr. Wilson, or someone stated earlier that buses were singled out for an earlier time frame because they were concentrated in the urban metropolitan areas, which had the highest concentration in those problems with compliance. How would delaying the deadline help address those needs? Because those are the areas where the compliance is not there, and it's usually not your eighteen-wheelers that are polluting the air in the inner-cities.

Mr. HEINLE. May I attempt to respond to that?

Firstly, If the bus industry delays purchase of vehicles, the goal is not accomplished regardless of the fact that they're zeroing in on buses. And particularly in the New York urban area, which I'm very familiar with being from North Jersey, the approaches to the—or crossings there are many, many more trucks in bumper-to-bumper traffic idling within that area, diesel trucks within that area that produce significantly more emissions than the diesel buses on those same approaches. Now, I'm not sure if that's true in other cities which don't have that impediment to access to the major metropolitan area.

But I believe the main issue is will this result in the bus industry in actual delay of procurement of buses, and will it do any good whatsoever towards reducing pollution and emissions? And if the bus industry reacts as many of my colleagues have told me they will, the answer is it will not. In fact, it could be a bigger impediment to achieving the emissions standards.

Mr. JENKINS. One of your major concerns, if I might just interrupt for a moment, is that as technology advances, we're afraid that if we have to make the conversions, and if we start purchasing the new vehicles at 1991, we really have to start this early next year. Our purchasing process takes us a year-and-a-half to two years once we start designing the specifications for a bus and actually end up with a product at the end of the system.

But what we're afraid of is the technology that is coming, and coming quite rapidly, is going to be put on us effective 1991, the technology will change so fast by 1994 that we're going to be sitting there with things that could possibly be outdated.

Mr. OBERT. Mr. Chairman, I'd like to add to that thought. In earlier testimony that we heard today, most of the questions directed to the speakers, I heard answers where they lumped the bus and truck standards together in terms of the ability to meet the standard. Another question was very interestingly answered. The diesel engines will not be killed off. Inasmuch as it was indicated that the only way the bus industry can meet the 1991 standard is with alternative fuels, it seems to me there's some real risk in a very real public policy question, inasmuch as a vast majority of the funding for public transit in this Country comes from the taxpayers. Is it sound public policy to make major investments in untested, and not totally developed alternative fuels for a three-year period, and

in fact have those investments obsoleted if in fact the expected trap technology that cleans up the diesel engine comes forward in 1994?

I think that's a real public policy question, and an investment issue that has not been discussed here at the table. As a bus manufacturer, we can install either diesel engines or alternative fuel engines. We, however, are concerned that if we are forced to meet the 1991 standards, and if alternative fuels are the only way to meet them, there will be significant economic and employment dislocation in the supply side of the bus industry. Quite frankly, our business would stop. Our people would have to be laid off or fired, awaiting the 1994 technology. Consequently, we have a vested interest in not necessary choosing between the technologies. We're working with methanol, with natural gas, and with trap oxidizers. Our major interest on the supply side is to indicate to our public policy makers, in fact, the very source of the funding for the vast majority of public transit, and indicate that there is some real risk in betting on the alternative fuel horse, when in fact, most of the technologists who testified here today suggested very strongly that diesel trap technology will be the winning technology in 1994.

Mr. McCURDY. The principal engine manufacturers that are for buses, are they generally U.S. manufacturers? Are there any international competitors out there?

Mr. OBERT. In answer to your question, Mr. Chairman, until three years ago there was only one manufacturer of engines for transit buses. That was the Detroit Diesel Corporation. In 1984 the Cummins Engine Corporation entered the market. There have been attempts by the foreign engine manufacturers to enter the market; Volvo has tried, MAN has tried, Saab-Scania has tried. Frankly, unsuccessfully. One of the major reasons being costs. There are some costs, especially recently with the current dollar exchange rate.

But more importantly, the transit industry has a very difficult maintenance job to perform, a very difficult maintenance job in a very hostile environment. Training is a very, very critical part of their service-delivery system. A bus that is improperly maintained will not make pull-out in the morning. The industry, the operators, our customers work very hard at training their people. And I have a difficult time training people to maintain diesel engines that have been available for 50 years. That's one of the main reasons that foreign engines have not been accepted in this country. It is a different product. It takes a whole new method of maintenance. And very frankly, it, in our mind, had a much larger, played a much larger role in keeping them out of this market than any economic or operating factors.

It's interesting in terms of the development of the alternative fuels. I'm not a technologist by any stretch, but I am led to believe that, or I know for a fact, that the one diesel engine manufacturer, Detroit, manufacturers a two-cycle engine; the other engine manufacturer, Cummins, manufacturers a four-cycle diesel engine. Two-cycle likes methanol; four-cycle doesn't like methanol, but likes natural gas. I think you can see why, perhaps, there has been more methanol development to date, than there has been natural gas development. Although, I might add, that it's my understanding that Cummins is working very hard now on the natural gas issue, but is

behind the methanol because of their relatively recent entry in the market.

Mr. MCCURDY. There's no threat—I'm not sure it would even be a threat—but there's no indication that Japanese or Europeans are going to be trying to compete in this area for your lower emissions?

Mr. OBERT. We are just in the process of completing a rather extensive study of the technology that exists offshore. There is no—I have no indication, at this point, that there is any technology from Asia which is as far along as ours in terms of alternate fuel. I am led to believe, though, that Europe does have some methanol technology, but it is by far not commercialized. It's still in the demonstration phase. And as we heard in testimony today, there is quite a bit of natural gas technology available in Europe, but it's my understanding that the majority of those applications are in light-duty vehicles, as opposed to heavy-duty vehicles which create and present some rather unique problems.

So as a bus manufacturer, we would welcome offshore technology if that was the only way we could meet the standards. Quite frankly, my concern is that that technology does not exist any more overseas than it does in this country, within the time frame, i.e. 1991, that we're challenged with.

Mr. MCCURDY. Very good. Gentlemen, I appreciate your traveling here, and your testimony today, and it's been very helpful for the record.

Mr. HEINLE. Thank you.

Mr. OBERT. Thank you.

Mr. JENKINS. Thank you for giving us the opportunity.

Mr. MCCURDY. The subcommittee is adjourned.

[Whereupon, at 3:48 p.m., the subcommittee was adjourned, to reconvene at the call of the Chair.]

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